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Compressor Casting Takes 31 Cores

More Than Usual Care Was Necessary in Setting the Cores Accurately For Thickness on Account of the Heavy Air Pressure Which the Casting Must Withstand

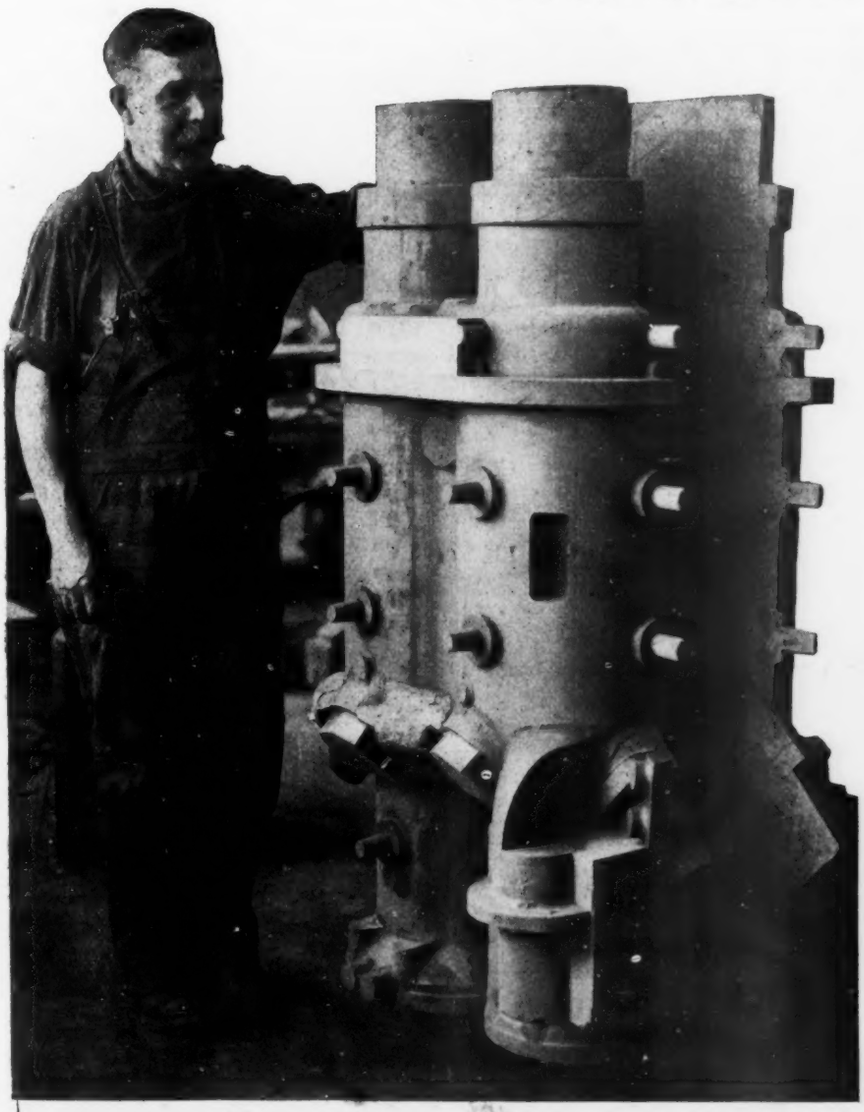


FIG. 1—THE ONLY LOOSE PIECE ON THE PATTERN IS A TRIANGULAR PRINT WHICH FITS INTO THE RECESS SHOWN. THIS PRINT LOCATES TWO BUTTONS WHICH ARE DRAWN AT A TANGENT

KNOWING the conditions under which a piece of machinery will have to operate a good engineer can usually design something to meet the requirements. When it comes to turning that design into something tangible, using some material substance which will answer the purpose intended, manufacturing difficulties frequently present themselves. These difficulties are sometimes of so serious a character that the design must either be amended or abandoned, but when that cannot be done the difficulties are only overcome by the exercise of the highest degree of skill, caution and judgment on the part of the manufacturer.

A problem of this character presented itself to the New London Ship & Engine Co., Groton, Conn., in connection with the construction of submarine engines. In this case the character of the design was rigidly limited and it was necessary, therefore, for the shop to meet the conditions laid down. The problem was encountered in its most acute form in connection with the construction of air compressors for fuel injection which are a necessary part of every diesel engine.

In an engine of standard type, the pressure in the cylinder at the time the fuel must be introduced, is about 400 pounds per square inch and this must not only be overcome by the pressure of the entering fuel, but it must be so far exceeded, that the required quantity will pass into the cylinder in about one-sixteenth of a second. Experience has shown that

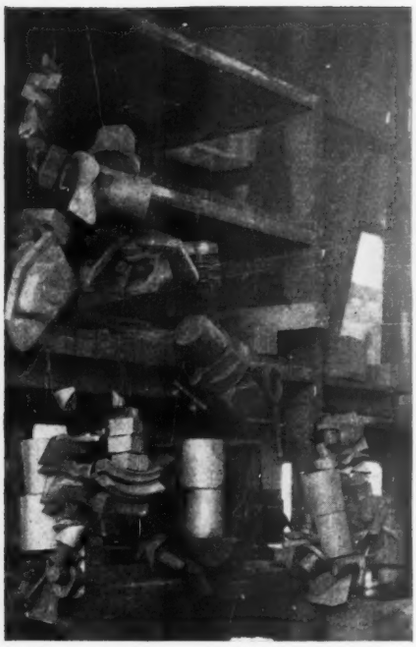


FIG. 2—ALL THE SMALL CORE-PATTERNS ENTERING INTO THE CONSTRUCTION OF THE COMPRESSOR CASTING ARE STRUNG WIRES TO PREVENT LOSS

for this work an air pressure of approximately 1000 pounds per square inch is necessary at the spraying nozzle. To provide this air and at the same time keep the weight and size of the compressor within the smallest possible limits, a one-piece casting was designed and made successfully.

Although the molding and general methods employed in the foundry of the New London Ship & Engine Corp. to produce this compressor *en bloc* are in no way radically different from practice in many other plants, still the fact that exceptional care was necessary in every detail and the further consideration that 31 cores are used lends the operation considerable interest as a practical molding problem. During the initial work of preparing the patterns much doubt was expressed on the part of old time foundrymen as to the feasability of the job. Molders and patternmakers, alike, said the piece could not be successfully cast. One man, however, John W. Robertson, in charge of molding operations at the plant, had faith in the design. He entered into the job heart and soul until the conception was a reality. In reducing this job to a practical manufacturing basis, a great deal of experimenting was necessary, but in this article only an outline of the method finally adopted can be presented.

Accuracy is Important

The patterns must be unusually accurate because an even thickness of wall is absolutely necessary for a working pressure of 1000 pounds per square inch. The main pattern for forming the mold is shown in Fig. 1. It is arranged for straight draft and the two halves are nearly identical. Two lugs are located at about the center of the pattern, projecting radially at about 45 degrees to the line of draft. If they were made part of the pattern it would of course be impossible to draw the whole piece without breaking away portions of the mold directly above the lugs; on the other hand if the lugs were made separate, in the form of buttons to be placed on the outside of the pattern it would be difficult to hold them to exact centers and also, being very small, they would easily be lost. To overcome this, the two lugs have been made part of a separate triangular block which fits into a recess in the pattern in such a way that the pattern itself may be drawn leaving the block with its buttons in place.

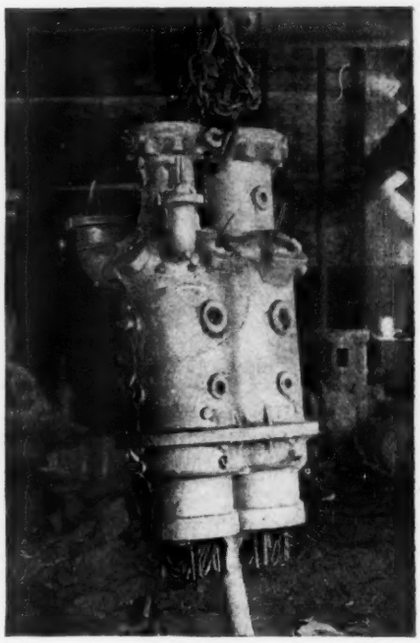


FIG. 4—THE CASTING AS FIRST TAKEN FROM THE MOLD BY THE CRANE WITH THE RODS STILL IN PLACE WEIGHS OVER 1600 POUNDS

This block, which is shown in Fig. 1, may thus be drawn from the recess at the necessary angle to prevent breaking the mold.

After drawing the halves of this main pattern and finishing the mold, the various cores, one after another, are set in place. These cores are made up in advance in sufficient quantity to offset the possibility of breakage at the time of making the assembly. The core-patterns and all small pattern-pieces are drilled to receive a stringing wire as a means of preventing them from being lost. Fig. 2 gives a good idea of the possibilities of saving time and avoiding the loss of small pieces by this method. It also conserves storage space.

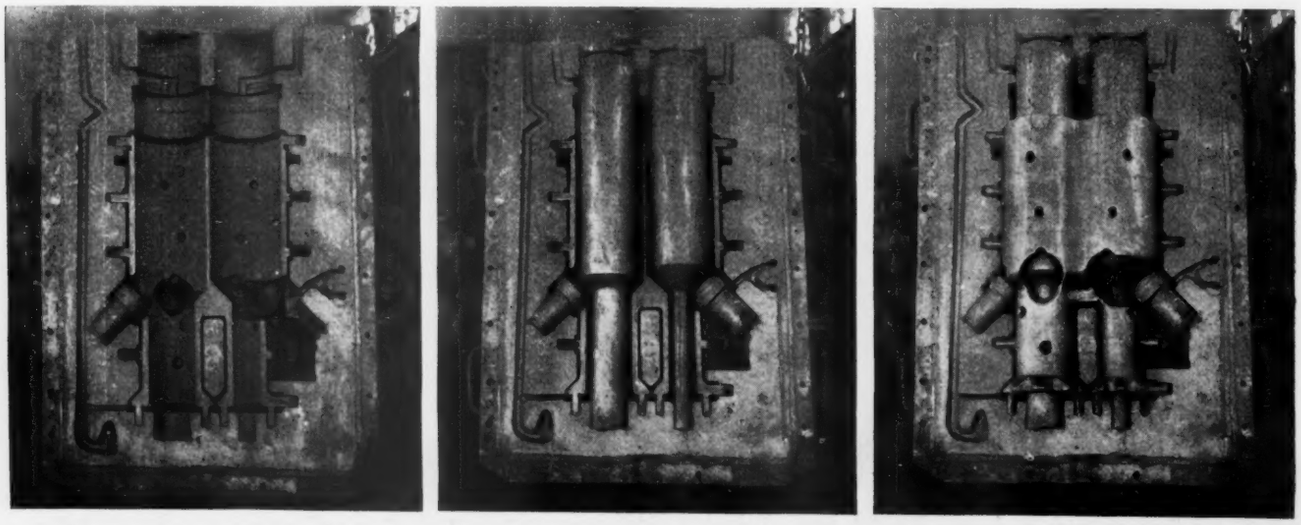


FIG. 3—THESE THREE VIEWS SHOW SUCCESSIVELY THE PLACING OF THE PRINCIPAL CORES. AT THE RIGHT, 31 CORES ARE IN PLACE IN THE DRAG READY FOR THE COPE

Some of the cores used are complicated and require unusual strength. The main water-jacket core is heavily reinforced and when completed is sufficiently rigid to permit somewhat rough treatment without breaking. This core is shown in place in Fig. 3. It is made up in two halves with projecting lugs at the parting. The reinforcing bars extend into these lugs which serve the double purpose of supporting the core and providing a purchase on the reinforcing wires for their extraction after the casting has been poured. The first or lower half of this core is laid in the mold and adjusted to correct position; then the cylinder cores, outlet cores, and other pieces are set in place and the upper half of the water jacket core is placed on top. It is wired to the lower half at the lugs which adds to the strength of the assembly and provides against slipping of one part over another. Finally the cope is lowered into place and the mold is ready to pour.

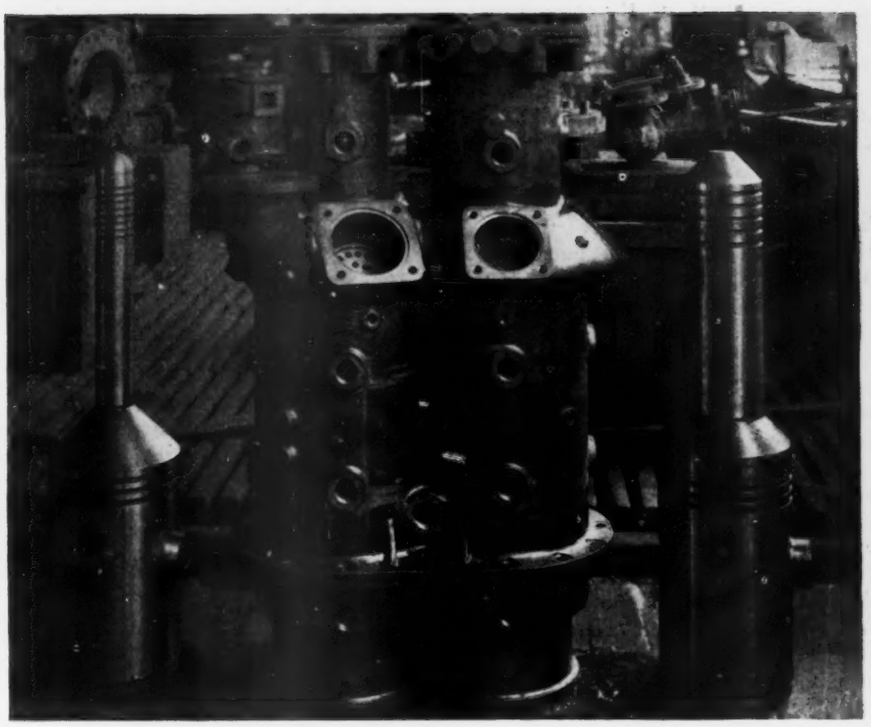


FIG. 5—THE CASTING WHEN COMPLETELY MACHINED BECOMES A THREE STAGE 1000-POUND PRESSURE AIR COMPRESSOR

The pouring is done from the bottom, that is, the gates are at that end of the mold which forms the bottom of the compressor. However, the mold is tipped up with the gates at the top when it is poured. The first portion of metal poured passes into the gate leading to the bottom of the mold (the top of the casting) and the second portion of metal goes through the central gate leading directly to the upper portion of the mold. This is accomplished by means of a pouring basin provided with three runners so arranged that the gate leading to the bottom of the mold may be filled first. The adjustment of many details has been necessary to make this pouring process completely satisfactory.

The metal at the bottom of the mold is under a static head of over 5 feet and some of the sand walls between different sections are only ⅛-inch thick. The casting, as poured, contains about 1600 pounds of iron and about 300 pounds of this are poured in through the gate leading to the bottom. In this way a sufficient quantity of hot metal is at the base of the mold to prevent spattering when the remainder of the metal passing through the central gates, drops in. The thin core walls are reinforced with strainer plates and many surfaces and corners of the mold proper are reinforced with nails and wires.

One important difference between this molding job and many others is the necessity of working to accurate dimensions. All fillets are down to size and the position of the cylinder cores is held to within exceedingly small limits. It can readily be seen

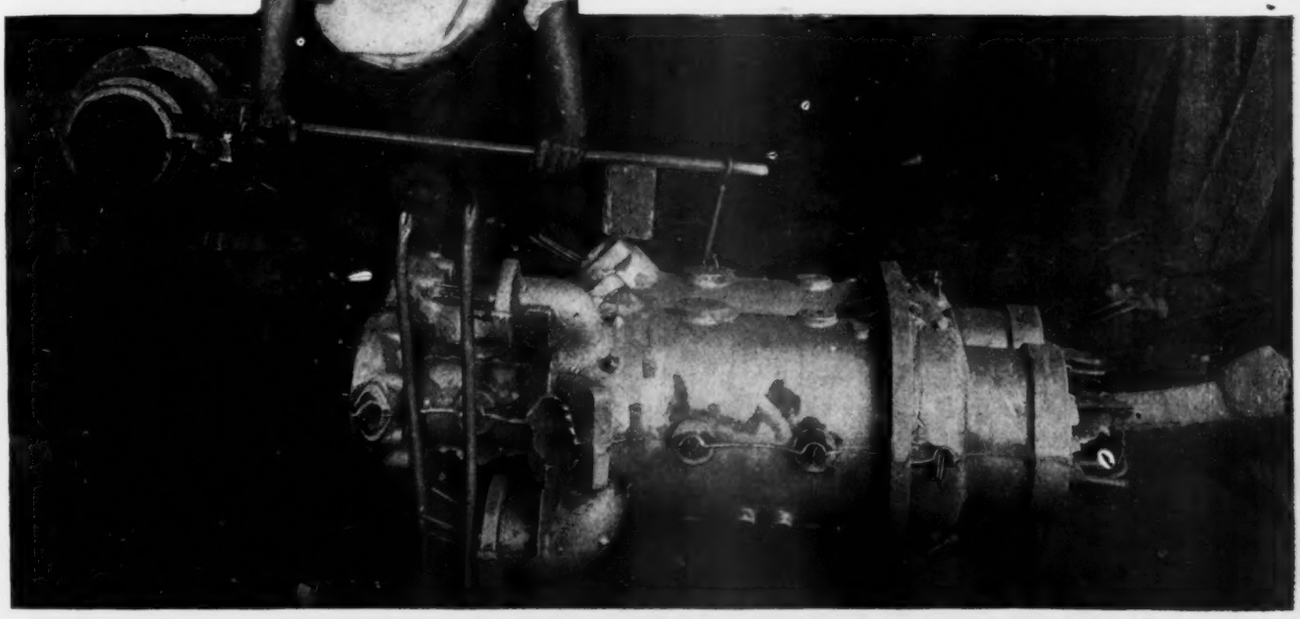


FIG. 6—IT IS A DIFFICULT TASK TO REMOVE ALL THE CORE WIRES. THIS IS DONE WITH SPECIAL HOOKS AND BARS

that on account of the sloping surfaces between high-pressure stage portions of the cores and the larger low-pressure portions, any longitudinal movement of these cores would mean a variation in the thickness of the separation walls.

When pouring first through the gate leading to the lower part of the mold, the metal drops 5 feet and several precautions are taken to reduce the tendency to spatter and freeze. An elbow is placed in the path of the metal to check its downward velocity and a sullage riser is arranged at the bottom for the purpose of collecting any frozen particles occuring at the initial impact of the metal with the bottom of the drop. Any such impurities tend to be forced to the top of this riser, thus permitting the clean metal to pass directly into the mold through a side tap as shown in Fig. 3. After the pouring has been completed and the casting has cooled it is lifted from the mold by a crane and is transferred to a cleaning room where the cores and core wires are removed. Fig. 4 shows the casting just as it has been taken from the mold.

Core Wires Hard to Remove

Fig. 6 shows the method of removing core wires. It is important to get all these wires and all core sand out of the casting, for any foreign substance would tend to interfere with the circulation of the cooling water. Most of the reinforcing wires are pulled out through openings in the casting by means of pinch bars and other tools. As some of the wires are long and crooked this process is not always easy. Some of the smaller wires run straight from top to bottom and are obtained simply by fishing with a short hook through the holes. Such a hook with the wire which it has caught is shown in Fig. 6. After the removal of all the core material the casting is cleaned up in the usual way and sent to the machine shop.

A view of a completed set of cylinders made from this pattern is shown in Fig. 5 together with the two pistons. Inasmuch as this casting job has some features unique in foundry practice a few of the details concerning its production will be given. The sand used is made up of 33⅓ per cent Jersey molding sand, 33⅓ per cent floor or heap sand and 33⅓ per cent of Cape Cod sand. This latter is a sand found on the beach at Cape Cod. It takes the same shipping rate as common sand. The whole mixture is mulled up and while in the mulling machine is tempered with clay water. The mold is baked before pouring and becomes so hard that a barefoot man could step upon any part of it without causing injury. The iron mixture used is low in silicon and its composition is as follows:

	Per Cent
Silicon	1.35
Sulphur	0.075
Manganese	0.70
Phosphorus	0.30
Carbon	2.50

The castings must have a high ultimate strength and are not accepted unless the specimens test between 30,000 and 40,000 pounds tensile strength and between 3000 and 4000 pounds transverse strength. The cores are all bonded with linseed oil. The water jacket core is heavily reinforced. Each half has twelve ¼-inch wires running from top to bottom and equally spaced throughout their length; that is, they start from the narrow part at the top of the high pressure cylinders and spread in conformity with the general shape of the core where it surrounds the large cylinders. In each half of the core nine cross wires run from the lugs on one side to those on the other side, three being brought out at each lug. These wires spread apart as soon as they leave the lugs and together with the 12 longitudinal wires form a basket-like network. Where the wires cross they are fastened together with pieces of small wire.

Strict instructions are given that there shall be no filing or rubbing of the cores to correct defects. If the cores are not correct as they are made they are thrown out. The wires are covered with flour paste to insure a good bond with the sand. The work being very accurate, it takes one man eight hours to core up the mold; the mold itself requires two men eight hours for ramming and two men another eight hours for finishing. It takes one man eight hours to remove cores and core wires from the completed casting.

The entire job while at first treated with a great deal of caution, has now become part of the foundry routine. The amount of loss in the foundry is barely 10 per cent, and when the necessity for correctly placing 31 cores is considered, this is seen to be moderate.

Foundry Contract Let

C. W. Sherman, associated with the Dominion Steel Co., Hamilton, Ont., is president of the Adirondack Steel Foundries Corp., Colonie, N. Y., which has awarded a contract to the Crowell-Lundoff-Little Co., Cleveland, for a new $300,000 steel foundry.

New England Foundrymen Meet in Boston

The New England Foundrymen's association held its first fall meeting at the Exchange club, Boston, Wednesday, Sept. 10. A. O. Backert, president of the American Foundrymen's association, was the principal speaker of the evening, and his description of conditions in Europe was of special interest to New England manufacturers, nearly all of whom have export questions in mind. Mr. Backert, who has recently made an inspection tour through the iron and steel district of England, told of the sympathy between the nations.

To illustrate the size of some of the English industries, Mr. Backert pointed out that one plant which he visited, turned out 25,000 tons of malleable iron per year. In many plants he found idle electric furnaces. The reason for this being that the extremely high price of electric power has made it impossible to continue the operation of these furnaces which were put in during the period of production frenzy, brought about by the war. Converters are used freely and a common installation includes a cupola mounted high enough so that metal flows by gravity directly into the converter. Mr. Backert stated that even now, under the crippled condition of Germany, with the whole Alsace-Lorraine district in French hands, that country still is second in pig iron production.

The franc, normally worth less than the German mark, now has a purchasing value in Germany of about three times its prewar value. In other words, for twenty cents in French money something over 60 cents worth of German goods can be purchased and how ever strong may be the sentiment against buying from Germany, it can hardly be expected to overcome the great advantage obtained through the difference in exchange.

Organize New Company

The Vibrating Machinery Co., capitalized at $50,000, has been organized and chartered at Chicago, and has taken over the entire business of the Schroeter Engineering Co., establishing a plant and office at 546 West Jackson boulevard. Julius Schroeter is president of the new concern, F. Von Schlagell is treasurer and Mrs. J. C. Miller, secretary. The company manufactures an oscillating foundry riddle and a gas unit for welding and cutting. The latter device is just being put on the market and is designed to use natural or city gas in connection with oxygen.

Experts Discuss Pulverized Coal

Design of Burner and Kind of Coal Used are Important—Economy Shown in Annealing Malleable and Tests With Powdered Coal on the Air Furnace are Recorded

FOR a number of years powdered coal has been used successfully for firing malleable-iron annealing furnaces, and recently a number of foundries have equipped their melting furnaces with apparatus for burning this type of fuel. While the data obtained so far have been too meager to warrant definite conclusions, the introduction of powdered coal into malleable-iron melting furnaces is without doubt being closely watched by producers in the hope of finding a means of dispensing with some of the labor required for the ordinary system of coal firing. For this reason the symposium of papers on the use of powdered coal presented at the annual meeting of the American Foundrymen's association in Philadelphia Oct. 1 is of special interest. Papers were presented by Charles Longenecker, the Bonnot Co., Canton, O.; A. J. Grindle, Combustion Economy Corp., Chicago, and Milton W. Arrowood, Ground Coal Engineering Co., Chicago. Mr. Longenecker gives data on an installation of powdered coal burning equipment on malleable-iron annealing furnaces which shows a cost of $2625 when using powdered coal, against $4900 for doing the same amount of annealing with natural gas and $8400 when using fuel oil. At another foundry a saving of 48 per cent has been effected in the quantity of coal consumed when it was used in the powdered form. The question of melting malleable iron in the air furnace with powdered coal is taken up by Mr. Arrowood. This question is not solely one of cost, but involves the effect of the flame and the ash from the coal on the metal and on the brickwork of the furnace. Not enough data have so far been secured to warrant definite conclusions but much information on the subject has been added by Mr. Arrowood's paper. That steel is being melted with 450 to 600 pounds of powdered coal per ton of charge and that 15 malleable foundries using powdered coal for annealing have a fuel ratio of from 500 to 700 pounds of coal per ton of castings is shown by Mr. Grindle. He also gives analyses of different coals which have proved satisfactory for use in the powdered form.

Develop Firing System For Air Furnace

BY MILTON W. ARROWOOD

VOLATILE pulverized fuel is highly combustible when dry, and if injected into a furnace at ignition temperature will ultimately burn as it finds air. But it is not believed that the highest efficiency is possible except where the greatest care is taken to introduce the air and fuel into the furnace as a completely diffused mixture. All problems calling for rapid and wide diffusion, whether it be a bursting hand grenade or the mere breaking up of a dust body call for action from the inside out.

A burner which has been designed to develop action of this kind is shown in Fig. 1. The powdered coal is fed by a screw feed into a perforated drum, *B*. Here it is met by a current of air blowing down on it from the pipe, *A*. The air and coal mix in this drum and are further mixed as they pass through the perforations and strike the walls of the encasing chamber, *C*. From this chamber they pass through the pipe, *D*, into the main chamber of the burner, which contains two or more sets of mixing shells concentrically arranged. In this chamber the main body of air is introduced through the conductor, *E*.

Having this type of apparatus, arrangements were made to conduct a series of tests on an air furnace at a plant in Meadville, Pa. Owing to some misunderstanding as to the method to be used in controlling the top blast, the original burner installed was designed to admit half the air at the top blast and take the remainder through the burner. This sacrificed at least half the mixing efficiency of the apparatus. A 14-inch duplex burner was used, capable of taking air enough for mixing and burning 1200 to 1500 pounds of coal per hour and a proportionately greater amount according to the amount of air admitted at the top blast. Pulverized coal was purchased from an outside plant, being that used ordinarily for annealing. It analyzed as follows:

	Per cent
Sulphur	1.34
Volatile matter	35.32
Fixed carbon	50.80
Ash	12.45
Moisture	1.43

Air was supplied by a No. 7 Sturtevant fan at a pressure on the fan outlet of five ounces, the line running some 40 feet to a Y-division supplying the two parts of the burner. The existing branch of the line supplying air to the ash pit was not disturbed. The burner was first lit with the furnace empty, the total air pressure at the burner being 8 inches and at the overhead blast pipe 4.25 ounces (difference due to pipe layout). The furnace was operated on this basis for 2 hours 12 minutes, the average coal fed being about one ton per hour.

At 1 hour and 20 minutes from starting time, a pig of iron was placed in the rear side door of the furnace and another in the front door. These were dripping freely in eight minutes. When feeding the full amount of coal, combustion was not complete until the flame came in contact with the top blast just over the bridge wall. Thus the principal heat zone was too far in the rear of the furnace. Coal was filled into the hopper by hand from bags of known weights, the amount of coal left at end of run being deducted. It was found that the feed screw had been delivering 0.3 pound per turn. The furnace was built for a charge of 10 to 12 tons.

The following day, a 2-ton charge made up of pig iron, hard scrap and railway malleable, showing an average of 0.914 per cent silicon and 0.627 per cent manganese was put in the furnace, which was then fired, without skimming bath, for 3 hours and 29 minutes, when the iron was poured, the fire being continued for 15 minutes while tapping out. A total of 5914 pounds of coal was used, or say three tons of coal for two tons of iron. The general character

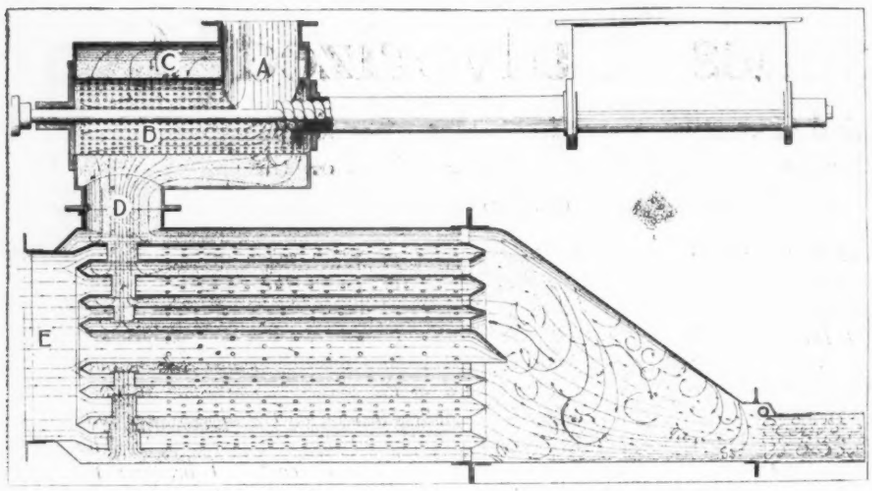


FIG. 1—BURNER DESIGNED TO THOROUGHLY MIX POWDERED COAL WITH THE AIR WHICH BURNS IT

of the metal was satisfactory but it was necessary to leave considerable slag in the furnace, owing to the condition of the bottom and the tap holes.

The brick covering that had been placed over the grates was removed at the bridge wall across the fire box for a space 1 foot wide lengthwise of the furnace. This made it possible to admit air through the ash pit under the fire in regulated amount. A 4-ton charge showing 0.902 per cent silicon and 0.62 per cent manganese was charged on the following day and on starting the fire it was at once seen that the large volume of air rising at the bridge wall deflected the flame to the roof and formed a cold blanket on the bath, thus making a slow heating furnace. The rear bridge wall had been built up two courses of brick and after running one and a half hours it was decided the fire was choked too much. Twelve minutes were lost in removing some of the brick, after which the fire was continued for a total of 5 hours and 52 minutes, including a short shut down to replace bung. The roof showed distress while the bath showed dull, attributed to the air condition above mentioned. Owing to the short charge it was not possible to skim the heat effectively, although it was partially skimmed after four hours. The total coal consumption was 10,300 pounds or 5.1 tons for four tons of iron melted in a 12-ton furnace. A test bar poured at 4 hours and 40 minutes showed silicon, 0.54 per cent, sulphur 0.102 per cent, phosphorous, 0.131 per cent, and combined carbon 3.50 per cent.

The opening over the grates was filled up and the eight 2-inch tuyeres on top blast were changed to 3-inch, the floor of combustion chamber was filled up to within 10 inches of top of front bridge wall. The outer end of the burner was raised and the discharge pointed at a downward angle against the front end of the charge. The burner was then lighted on the empty furnace for 1 hour and 15 minutes, it being desired to start a charge with a hot furnace. A 5-ton charge of the same composition as the previous heat was then fired for 4 hours and 55 minutes, with shut down of 5 minutes on account of the loss of a bung. The total coal fed was 9088 pounds or an average of 1725 pounds per hour, or a total of 4.5 tons for 5 tons of iron in a 12-ton furnace, with a considerable amount of slag left in the furnace from previous heats that could not be skimmed properly. The quantity of metal was sufficient to permit fair skimming and at 3 hours and 30 minutes a considerable amount of slag of good appearance was skimmed off. At 4 hours and 10 minutes a test bar showed 0.73 per cent silicon and 0.968 per cent sulphur, while a second bar poured at tapping out 4 hours and 40 minutes from starting showed as follows:

	Per cent
Total carbon	3.20
Combined carbon	2.78
Graphitic carbon	0.42
Manganese	0.30
Phosphorous	0.155
Silicon	0.98
Sulphur	0.06

A test bar poured from a ladle taken off during tapping out showed 0.68 per cent silicon, 0.081 per cent sulphur and a tensile strength of 35,600 pounds. Another analysis from pig, taken in same way, showed as follows from a different chemist:

	Per cent
Silicon	0.67
Sulphur	0.048
Manganese	0.44
Combined carbon	1.55
Graphitic carbon	1.20

Analysis of iron from hand fired furnaces in the same plant showed as follows:

	Per cent
Silicon	0.59
Sulphur	0.092
Phosphorous	0.156
Manganese	0.26
Combined carbon	2.97
Total carbon	2.98

As a result of this test, it was conclusively shown that all of the air should be admitted through the burner and arrangements were then made to set up a burner of sufficient capacity for this purpose. At the time of preparing this paper for presentation reports on additional heats have not become available. It is hoped that further data will be available later.

A 30-inch burner has been installed on a furnace, built for a capacity of 10 to 15 tons in a prominent foundry in Erie, Pa. A view of the burner attached to this furnace is shown in Fig. 2. Acting on the idea of having the initial com-

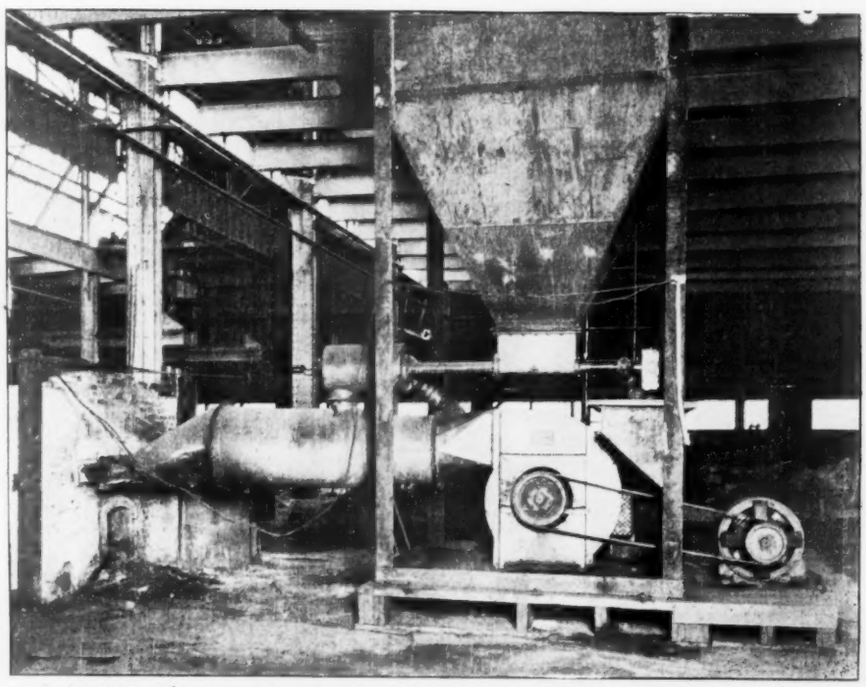


FIG. 2—POWDERED-COAL BURNER ATTACHED TO AN AIR FURNACE

bustion occur on the front end of the charge, the combustion chamber was made only about 2 feet in length from the noze of burner to the front bridge wall. For reasons noted, this proved to be unsatisfactory and it was considered desirable to lengthen the combustion chamber about 7 feet, thus completing combustion by the time the gases reach the bridge wall so that the extremely hot gases come in contact with the charge.

This lengthening of the furnace, together with other minor changes and adjustments, as well as insufficient mill capacity to supply coal for full time operation, and the fact that the conveying system from the mill to furnace hopper has not been installed, caused delay in placing the furnace in regular operation. It is contemplated to put this unit in daily service as soon as circumstances permit.

In malleable iron annealing, the powdered-coal burner performs functions equally as satisfactorily as in the air melting furnace. For greatest economy in the use of pulverized coal, the ovens should be of comparatively large size. It then becomes a problem of uniform heat distribution and control so as not to burn the pots. With some types of pulverized coal burners it is found that the heat is thrown in too great degree toward the front end of the ovens. At times the poor heat distribution with high velocity burners results in burning top pots near the burner, while the bottom ones on the same stools may not be annealed. Where a cutting flame cuts down the brick on the firebox, the destruction of pots near the burner may be aggravated from slag deposition and fluxing. At other times, if the coal happens to be a little damp or not ground as fine as usual, some of it may be deposited on the floor and blanket the bottom pots near the burner.

While no commercial installation has yet been made on the muffle type of annealing oven, a number of test runs were made on such an oven handling railway castings. In a plant having 26 ovens of a capacity about 25 tons each, the practice with hand firing was to secure one pound of castings annealed per pound of coal. An improved form of oven was constructed and on a specially conducted test showed a ratio of 2.2 to 1. A 6-inch powdered coal burner on the same oven showed a ratio of 5.2 to 1 and the test record of flue temperature (presently to be mentioned) indicated that the length of this oven could be increased 6 feet without using any more coal, in which case the ratio would be 7.25 to 1. The difference between 1 pound of castings and 7.25 pounds per pound of coal is shown to be very great. On this basis 14 ovens will do the work of 12 and there is a capital saving of $24,000 besides space released for several molding floors, etc.

The total time of firing, however, was 49.5 hours as compared to the usual hand firing period of 90 to 110 hours on the same ovens. The special hand-fired test showing ratio of 2.2 to 1 was made in 72 hours firing time. The total coal consumption on this run was 9650 pounds and 25 tons of castings were annealed, making the ratio 5.18 to 1. The castings were of excellent quality.

Powdered Coal for the Small Foundry

BY A. J. GRINDLE

THE use of powdered coal for fuel has interested foundrymen, manufacturers and engineers for over 100 years, but until the last few years its practicability has been doubted by most engineers owing to the great number of failures which have been made in its preparation and burning.

In malleable and steel foundries using 10 tons of coal per day, or its equivalent in oil, gas or coke, the use of powdered coal for fuel is practical in the opinion of the author. There are several open-hearth furnaces now using this fuel; steel is being melted with 450 to 600 pounds of coal per ton of charge. There are about 15 malleable foundries using powdered coal for annealing, the fuel ratio on these ovens being from 500 to 700 pounds of coal per ton of castings; much time is being saved in bringing the ovens up to annealing temperature. Malleable iron has been melted with 31.2 per cent coal to iron, a 12-ton heat being melted in three hours and 40 minutes with a ton more scrap than usual in place of pig iron.

Steam boilers are being fired with powdered coal and 8½ to 11 pounds of water per pound of coal are being evaporated. If a foundry is equipped with a powdered coal plant it is practical to fire the core ovens with this fuel.

In addition to the fuel saving and savings effected in decreased oxidation of the metal, I believe a saving of 25 per cent to 75 per cent in labor can be made. A uniform temperature can be maintained and therefore a uniform product. Core ovens and steam boilers can be equipped with a thermostatic control and the heat controlled as easily as with gas.

Heretofore the small foundry could not use powdered coal for annealing owing to the high cost of an installation compared with the possible savings, but now it is practical for even the small foundry, since it can be used in all departments where fuel is consumed.

Feeding and Burning Coal

No matter how well coal is dried and pulverized, proper combustion cannot be secured without a uniform feed of coal, thorough carburization with air, and means of easily and accurately controlling the coal and air supply. Equipment has been perfected which overcomes many of these difficulties.

Powdered coal has a tendency to pack in the storage hopper, especially when it stands a few days before burning, and if the opening in the hopper bottom is too small the coal will arch over the feed screw and stop the fuel supply. This trouble has been corrected by a specially designed feed screw enclosed in a cast-iron hopper bottom with a large top opening. This feed worm will feed throughout its full length. The coal gradually loosens up toward the discharge end in place of packing. At the discharge end there is a revolving disk which breaks up any packing of coal which might take place along the feed screw. Packing causes an unsteady feed of coal and a pulsating flame, but it is believed this system eliminates this fault and produces a uniform feed, resulting in a steady continuous flame.

Coals best suited for burning in a powdered form are those rich in volatile matter, such as bituminous and semi-bituminous, either slack or run-of-mine. The slack has an advantage over the run-of-mine as it is not necessary to crush the former before drying.

The following analysis represents a coal which has been found to give good results on melting furnaces:

	Per cent
Fixed carbon	60.12
Volatile matter	35.80
Ash	3.08
Moisture	1.00
Sulphur	.38
B.t.u.	14,650

Good results have been obtained in annealing ovens and steam boilers from coal of the following analysis:

	Per cent
Fixed carbon	53.26
Volatile matter	29.00
Ash	16.34
Moisture	1.40
Sulphur	1.80
B.t.u.	12,600

Qualities of anthracite lignite and peat, as well as the inferior grades such as anthracite culm, dust and slush, and bituminous and lignite slack screenings and dust are all suitable for burning in pulverized form, for certain kinds of work, when dried and properly mixed with a higher volatile fuel. For the proper igniting and burning of powdered coal the volatile content should be 20 per cent or more, while the quality of the fuel is an important consideration the conditions under which it is burned are more so.

The cost of preparing powdered coal for burning runs from $0.46 to $1.00 per ton depending on the amount pulverized. The cost of an installation runs from $18,000 to $150,000 according to the capacity and number of the furnaces to be fired.

Using Pulverized Coal for Annealing

BY CHARLES LONGENECKER

THE first installation of powdered coal burning apparatus on malleable iron annealing furnaces was at the plant of the Erie Malleable Co., Erie, Pa., where B. J. Walker adopted this method of heating in 1896. Since that time numerous other installations have been erected. The Pressed Steel Car Co., Pittsburgh, formerly the Pennsylvania Malleable Co., made its initial application of powdered coal to annealing furnaces in the fall of 1917, and since then these furnaces have been in continuous operation. In this plant each air furace is practically all below the floor level. There are 10 large and 18 small furnaces, some of which are used for annealing steel castings. The larger ones have a capacity of 50 tons, while the smaller hold 25 tons. Fig. 1 shows a longitudinal cross section of the large furnace and Fig. 2 a transverse section.

As is well known, the requisites in an annealing furnace from a thermal standpoint are a uniform temperature (and consequently heat) throughout the heating chamber and the maintenance of a constant degree of heat for the proper length of time. To secure these conditions, it was necessary to install four burners in each furnace and maintain a steady flow of coal to these burners. The following table shows a typical run and illustrates how well conditions have been met:

July		
10	Noon, furnace lighted.	
11	1600° (6 A. M.)	1630° (6 P. M.)
12	1640° (6 A. M.)	1620° (6 P. M.)
13	1620° (6 A. M.)	1600° (6 P. M.)
14	1640° (6 A. M.)	1620° (6 P. M.)
15	1620° (6 A. M.)	1640° (6 P. M.)
15-16	1620° (9 P. M.)	1640° (3 A. M.)
16	1620° (6 A. M.)	

From the foregoing we obtain the following summary:

Furnace lighted, July 10, noon.
Time to bring furnace to temperature 1600 degrees, 18 hours.
Furnace held at temperature, 1600 degrees, 120 hours.
Firing discontinued, 6 a. m., July 16.
Bungs (roof) removed, 6 a. m., July 18.
The castings were then removed as soon as they were cool enough to handle.

A pyrometer is inserted in each end of each furnace. Each one is connected to a central instrument. It is the duty of the furnace attendant to read the temperature of each furnace at frequent intervals on this instrument, so that there is little chance for any wide fluctuation in temperature. One attendant supervises all the furnaces.

With powdered coal it requires from 14 to 18 hours to bring the furnace to 1600 degrees, with fuel oil the time is 22 to 24 hours, and with natural gas about 26 hours. From the foregoing it seems apparent that powdered coal gives results which are thermally satisfactory.

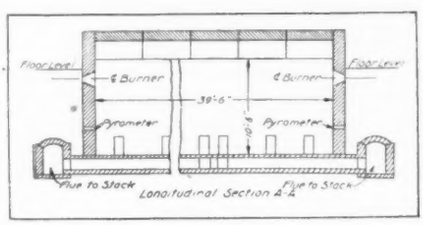


FIG. 1—LONGITUDINAL SECTION THROUGH ANNEALING FURNACE AT *A-A*, FIG. 2

There is an accumulation of fine ash which must be removed from these furnaces at intervals. The length of these intervals will depend on the percentage of ash in the coal. When the coal has a low ash content the accumulation is removed once a month. In the standard type of furnace, where the heating chamber floor level is at general floor level, the disposal of ash is of small moment, due to greater accessibility of both heating chamber and flues.

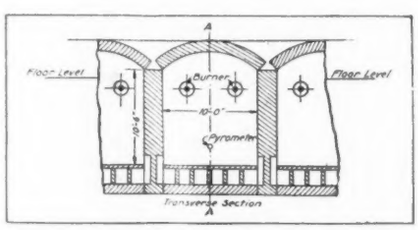


FIG. 2—TRANSVERSE SECTION THROUGH ANNEALING FURNACE

As is well known, in annealing malleable castings a fluctuating temperature must be avoided and at no time is it permissible to allow the temperature to fall below the critical range. To secure this control of the heat requires close regulation of both the fuel and the air to burn it. No trouble has been encountered in holding these conditions constant.

A comparative record of costs for three fuels is as follows:

Natural gas, 14,000,000 cubic feet, at 35c per 1000, $4900; fuel oil, 105,000 gallons at 8c, $8400; powdered coal, 525 tons at $5 per ton, $2625.

The figure $5 given as the cost of powdered coal includes besides the coal all labor, power, etc. These costs are taken from actual practice and cover three separate months during each of which one of these fuels was burned.

In another malleable iron foundry where powdered coal is now burned in the annealing furnaces, a saving of 48 per cent has been effected in the quantity of fuel consumed. In this case the amount of powdered coal burned per ton of output is 450 pounds. The time to bring the furnace to temperature has been reduced from 24 to 36 hours, required for hand firing, to 11 to 14 hours. When hand fired, there was always a difference in temperature in these furnaces of from 200 to 300 degrees between the front and rear. Today, when fired with powdered coal, this temperature appears to be uniform. This is accounted for by the fact that the pressure in the furnace is equalized, as it is impossible to obtain a uniform temperature throughout the chamber unless the furnace is under a slight pressure. With stack draft and hand firing it is exceedingly difficult to avoid pulling in some cold air, especially at the door. This makes a cold streak and naturally it is impossible to secure a uniform temperature under such conditions.

Besides malleable castings, the Pressed Steel Car Co. also manufactures steel castings. They are an-

nealed in the same furnace as the malleable castings. The temperature carried when annealing steel is 1660 degrees Fahr. One of these furnaces was lighted at 3 p. m., July 15, and firing discontinued at 11 a. m., July 16, so that the total time required for the annealing was 20 hours. The coal consumption was 140 pounds per hour.

Fig. 3 shows the tops of the furnaces and the pipes through which the coal and air are delivered to the burners. The large spiral riveted pipe on top carries the coal, while the secondary air flows through the lower one. Two-inch wrought iron pipes branch from these. The latter are connected at their upper ends to the control valves, shown in the illustration, which regulate the flow of coal and air to the burners. Their lower ends terminate at the burner.

The coal which passes through the upper pipe is of course very fine, as it must be held in suspension throughout the length of the pipe. The principle of distribution is as follows:

The coal is received in cars and after being dried is pulverized and then conveyed pneumatically to a substation at the foundry building. Here it is separated from the high pressure air and falls into a 25-ton bin. Two spiral screws feed the coal from this bin into a pipe connected to the suction side of the fan. This fan has a capacity of 6000 cubic feet of air per minute. In the fan the fine coal is mixed with air in the proportion of 1 pound of coal to 60 cubic feet of air. This mixture is then forced through the pipes and delivered to the burners as desired by the furnace attendant. As is well known, it requires at least 200 cubic feet of air to form a combustible mixture with one pound of coal that is burned.

There is, therefore, no danger of combustion until the necessary additional 140 cubic feet has been added at the burner. The ratio of 1 pound of coal to 60 cubic feet of air is maintained automatically by a very simple electrical contrivance. If desired, the ratio can be changed and the machinery set to hold it constant.

The Globe Foundry Co., Sheboygan, Wis., recently has been incorporated by G. F. Honold, Gus A. De Wilde Jr. and Fred Leicht. The new company will take over the Globe Co., and will extend its facilities by the construction of a new gray iron foundry. The present foundry will be converted into a machine shop to handle general machinery manufacture.

Why Facing is Necessary

Foundry facings are applied to the surface of molds for the purpose of preventing adhesion between the metal and the sand of which the mold is composed. When the facing performs this function properly, a casting is secured which requires little or no cleaning, thus effecting a great saving in the operating expenses.

The saving is not confined to the item of cleaning, but also appears in the reduced cost of machining due to the absence of burnt sand on the surface of the casting. When facings of the better quality are used, the castings are of that fine bluish gray color so much desired by the progressive foundryman.

The reason why a graphite or *silver lead* facing prevents the sand adhering to the metal is as follows:

Graphite is one of the forms of carbon and is a combustible material. When molten metal is poured into the mold, the air in the mold and the air carried in by the stream of melted metal furnish oxygen enough to bring about a certain amount of combustion, forming a gas between the metal and the mold. This effectually prevents adhesion of the metal to the sand, and just as long as the gas film exists no adhesion can possibly occur.

Pure graphite will not adhere of itself to the mold surfaces, but will run before the metal the moment the sand dries. To prevent this, it is necessary to add a binder to hold it in place. The proper proportioning and selection of this binder is a matter of the utmost importance. Facings with a large percentage of binder are more difficult to slick than those with a low percentage. Therefore they are indicated where the sand is used quite dry. It is common experience that facings used during the summer months with the utmost satisfaction, are found fault with when winter months come, because they don't slick well. This is most often experienced in foundries which are not well heated and which become unusually damp in cold weather. The sand does not dry out so rapidly as in the summer, and is consequently just a little damper when used. This accounts for a difference in the working of the facing.

There are four general classes of work that require different facings: Green sand, loam, dry sand and cores.

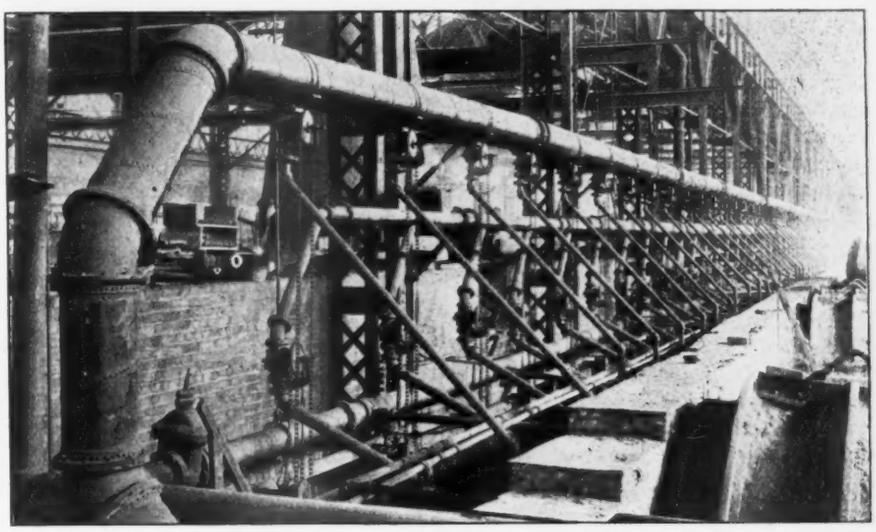


FIG. 3—VIEW ALONG TOPS OF ANNEALING FURNACES SHOWING PIPES FOR CARRYING AIR AND POWDERED COAL

Green sand molding is by far the most common, and is used for nearly all iron molding done in flasks. *Green sand* means damp sand that can be packed sufficiently hard to retain its shape. Facings are dusted on, and slicked by hand.

Dry sand molding differs from green sand in that after the mold is finished, the flasks are placed in a drying oven and thoroughly dried. Facing for dry sand is mixed with water and applied to the hard surfaces as a wash.

Core work. If the casting is to be hollow, a core of the proper form is suspended in the mold, so that after metal is poured the core can be knocked out and leave a hole of any desired shape within the casting. Cores are commonly made of flinty sand mixed with some kind of binder and baked hard. They are then coated with a graphite wash, the same as for dry sand work.

Good castings depend largely upon good facings, or at least good castings are impossible with poor facings. On the other hand, it is necessary that the facing be available at a reasonable cost consistent with quality.

Machining Qualities of Malleable

Cutting and Drilling Tests Were Made on Malleable Iron Samples With Different Physical Properties to Determine Relation of High Elongation and Tensile Strength to the Machinability of the Metal

BY EDWIN K. SMITH AND WILLIAM BARR

DURING the past year or so, there has been considerable discussion of the machining qualities of malleable castings. At the same time there has been a decided tendency toward raising the physical characteristics, especially the tensile strength and elongation. This naturally has brought up the question: "What effects have the higher physical properties had on machinability?" There are wide differences of opinion in regard to this, and as the subject is of importance to manufacturers, as well as to users of castings, it seemed advisable to collect the available data, in order to present at least a preliminary report at this time. On getting in touch with various foundries, it became evident that there are two general opinions, and that practically every concern has a strong leaning toward one or the other of these opinions.

Opinions Differ

One set maintains that machinability is practically independent of physical characteristics, and that castings showing high tensile strength and elongation machine quite as well as those with lower physical properties. The other group feels equally strongly that in certain lines of work, where extremely high strength is not necessary, greater ease and speed of machining can be obtained by using a metal with lower physical characteristics. There is no question as to what metal to make when great strength is the one essential requisite.

There is little literature on this subject. A paper presented at the American Foundrymen's association convention in Boston in 1917 recommends the manufacture of malleable with high characteristics, but admits that with such extra good material, the user may have to increase the strength of his machine tools, and decrease the cutting speed.

Another noted authority wrote: "In looking over these records, it is only fair to consider, that included in them are bars from concerns in which high strength and ductility have been sacrificed, in order to secure such a character of metal, as would machine with the greatest ease, this property in these particular cases being the predominating requirement." Also "One thing is certain, that as in the case of steel, the malleable iron casting that machines most kindly, is as a rule, the one poorest in physical properties."

Theoretically it would seem probable that a high tensile strength in any metal, would increase difficulty in machining, if we consider that the tensile test consists of tearing apart the particles of iron, until the bar is fractured, and that a good part of the action, of any cutting tool, consists in a similar tearing apart of the particles of iron.

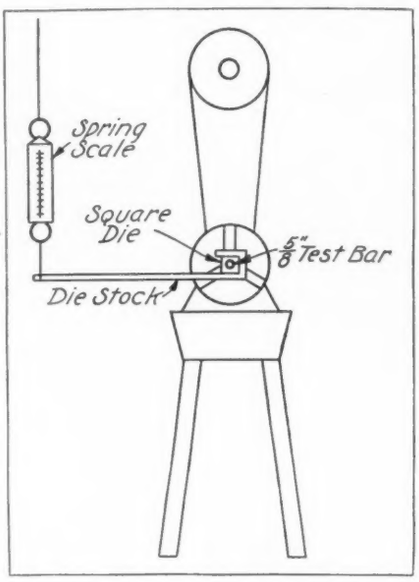


FIG. 1—END VIEW OF MACHINABILITY TESTING MACHINE

In order to obtain the ideas of those whose experience would qualify them as judges, we wrote a number of malleable foundries, and the replies showed considerable difference of opinions. A few quotations will suffice:

1—"Very high tensile strength and high elongation malleable machines quite well."

2—"Iron of 50,000 or 55,000 pounds tensile strength, with elongation 12 to 15 per cent is easily machined; 100 per cent of this iron is machined at high speed—without the least trouble."

3—"There is no question but that very high tensile malleable iron will not answer for the small castings on which a great deal of finishing is done—where the quantity finished per hour is a matter of prime importance. High tensile material is a necessity for car work."

4—"Unless we were able to do this (vary our mixture) our tool cost for machining these castings would in some cases be enormously increased."

It is rather significant that the product of manufacturers of light castings, especially those extensively machined, as a rule, averages considerably lower in physical tests, than that of makers of heavy castings, although both classes of castings give excellent results under actual service conditions.

The Test of Practice

It is particularly noticeable that the majority of concerns which both make and machine certain lines of small castings, prefer a metal of medium low test, as they find that the strength of this metal is ample, and machining qualities superior.

In view of the foregoing opinions, it seems obvious that there is need of some definite method for determining a machinability figure. It has been amply demonstrated that none of the methods for determining "hardness" gives any idea of machinability of malleable castings.

As by far the greatest part of the difficulty with high speed machining has been with the threading operations, we have endeavored to devise an apparatus to give a machinability figure, based on threading. We simply used an engine lathe, as indicated in Fig. 1. The pieces first tested were the standard ⅝-inch tensile strength bars, with one end sawed off. The remaining large end was held in the chuck. A standard die was held in a stock, and was forced on the ⅝-inch end of the test bar. To one end of the die stock was attached a rather accurate spring scale. When the chuck was revolved, a ⅝-inch thread was cut on the bar, and the pull required to cut this thread was of course registered on the scale. Giving the scale readings it is of course simple to calculate the actual pull on the die in cutting.

Samples were obtained to cover the range of 42,000 to 52,000 pounds tensile strength per square inch. Table I gives results of the first series.

A paper presented by Edwin K. Smith and William Barr at the annual convention of the American Foundrymen's association held in Philadelphia Sept. 29 to Oct. 3.

The speed was 27 revolutions per minute; die, U. S. Standard 5/8-inch.

These bars were all very nearly 5/8-inch diameter, and were very free from any irregularities of surface. The results are arranged according to the ease of machining, and it will be noted that generally speaking, the ease of machining decreases with increasing physical characteristics.

Thinking that possibly the small differences in diameter might affect results, we next selected a series of similar bars, and machined each to exactly 5/8-inch. These were threaded results being shown in Table II; speed 27 revolutions per minute; die U. S. Standard 5/8-inch.

In order to vary conditions, we next prepared castings with 1-inch diameter, and repeated the test, using a U. S. standard 1-inch die, speed 14 revolutions per minute. The surface of the castings was not machined before threading.

Drilling Tests

While these results, which are given in Table III, show very great variations, it is obvious that on the whole, ease of machining is sacrificed to higher physical characteristics.

It seemed possible that a drilling test might throw some light on the subject, so we fitted a vertical drill press, as shown in Fig. 2. A 50-pound weight was fastened on top of the spindle, the combined weight being 65 pounds. The spindle being thrown out of feed gear, we thus had a constant pressure on the drills, all of which were 15/64-inch in diameter. The speed was 206 revolutions per minute. The results are shown in Table IV. Time to drill through 3/4-inch bar was determined by stop watch.

Although we have a wide variation in physical figures, we are unable to see any relation between these and speed of drilling.

One point which came up in this test, and which probably has some effect on difficulty in threading high tensile, high elongation iron, was that produced by the length of chip cut. The approximate length of chip made by cutting tool is given in the following table:

No.	Tensile Strength	Elongation Per Cent	Length of Chip, Inches
C	46550	11.5	3/4
5.15-6-N	48000	9 5	2
5.13-5-N	51870	18.0	5
U	50650	11.5	6

Obviously the longer the chip, the more trouble will be caused in threading, especially on the return operation, while with any ordinary cutting work, the long chip will do no harm.

While the results of all the foregoing tests are suggestive, it is obvious that in order to be in anyway conclusive, they must be repeated, under better conditions, and we believe that a very much faster feed would give better results. As our equipment is not suited for high speed on this work, we wrote the University of Wisconsin, and have recently received a letter, stating that the mechanical engineering department would be glad to run conclusive tests on this subject in the fall. They are especially well equipped for such work, and if it can be arranged, we should get conclusive figures from their tests.

From the foregoing experiments, and from all data available to us, we can venture the following opinions:

First.—At medium speeds, all properly manufactured malleable castings can readily be machined, whether such castings are of low or of moderately high physical characteristics.

Second.—Where speed of machining is of greater importance than great strength, a metal of say 42,000

Table I

Results of First Machine Test

No.	Decarb. Depth	Tensile Strength	Elas. Limit	Elongation Per Cent	Lbs. Actual
8	0	40560	33333	7.0	794
1		47680	36220	7.0	843
N5.15-6	1/64	48000	35330	9 5	843
22		48295	34590	9.0	870
121		49190		12.0	952
N5.13-5	2/64	51870	37330	18.0	963
31425	4/64	46620	34380	7.5	979
U	3/64	50650	34950	11.5	1224
16		54320		10.0	1360

Table II

Second Machine Test

No.	Decarb. Depth	Tensile Strength	Elas. Limit	Elongation Per Cent	Lbs. Actual
31418	3/64	41870	31000	7.0	625
3159	7/64	42840	31400	7.0	772
3164	5/64	40300	31710	6.0	893
31414	1/64	50120	35140	7.5	898
31526	2/64	43500	30870	7 0	9 8
31512		46870	31000	9.0	952
Gray Iron Bar		27370	27370	0.0	9.9
Cast Steel		54950	38210	10.0	1034
Gray Iron Plate					1077
31513	4/64	43720	32610	8.0	1104
3165	3/64	44210	33150	7.0	1137
Soft Steel					1496
Hard Steel					1676

Table III

Machine Test on Larger Bars

No.	Tensile Strength	Elastic Limit	Elong. Per Cent.	Lbs. Actual
Gray Iron	27370	27370	0.0	1226
-1°	45740	33140	7 5	1294
1-6°	42640	32000	9 5	1310
X2-3°	41110	36690	6 0	1310
N-5.15-6	48000	35330	9 5	1134
2 8°	42060	31020	9.0	1369
1X-4°	43750	36410	7.0	1428
3X-2°	44680	34520	7.5	1453
U	50650	34950	11.5	1495
C	46550	30260	11.5	1537
N-5.13-5	51870	37330	18.0	1537
Cast Steel	54950	38210	10.0	1596

Table IV

Results of Drilling Test

No.	Decarb. Depth	Tensile Strength	Elas. Limit	Elong. Per Cent	Time Min. and Sec.	Inches Drilled	Inches Per Min.
Gray Iron Slab					3-2.0	.7559	.249
3-31425-	4/64	46620	34380	7.5	3-9.0	.7559	.240
4-31415-	3/64				3-9.1	.7559	.239
2xx-5-15-6N	1/64	48000	35330	9.5	3-11.0	.7480	.235
2-	7/64				3-16.3	.7559	.231
2x-3165-	3/64	44210	33150	7.0	3-26.5	.7911	.230
7-3149-	4/64				3-21.5	.7716	.230
4x-3159-	2/64	43500	30870	7.0	3-23.5	.7677	.226
5-3159-	7/64	42840	31400	7.0	3-26.0	.7753	.226
6-3151-	2/64				3-22.2	.7598	.225
1x-31513-	4/64	43720	32610	8.0	3-30 6	.7795	.222
5x-3164-	5/64				3-28.2	.7677	.221
3x-31515-	4/64	45480	33580	7.5	3-28.2	.7637	.220
1xx-5-13-5-N	2/64	51870	37330	18.0	3-25.0	.7480	.219
8-31414	1/64	50120	35140	7.5	3-29.9	.7637	.218
5xx-8	0	40560			3-31 2	.7519	.214
1-31418-	3/64	41870	31000	7.0	3-34.2	.7598	.213
4xx-C	3/64	46550	30260	11.5	3-36 0	.7519	.209
Gray Iron Bar		27370	27370	0.0	3-55.6	.7677	.196
3xx U	3/64	50650	34950	11.5	4-37.4	.8346	.181
Steel Soft					8-45.1	.7480	.085
Steel Cast		54950	38210	10.0	13-44.4	.7559	.055
Steel Hard					14-2.2	.7322	.052

The column in Tables I, II and IV marked "Decarb" gives the depth to which the carbon was burned out in the anneal. From these preliminary experiments, the authors were not able to find any relation between depth of decarbonized rim, and machinability.

pounds tensile strength, and 6 per cent elongation will give the best results.

To our minds, a very interesting point was brought up by results on machining bars of various kinds of steel and gray iron, as shown in tables II, III and IV. Of course too much cannot be judged from a test on a few samples, but from the figures shown we notice that the following results hold through the series of tests:

First.—The malleable bars machine approximately as easily as the gray iron.

Second.—The malleable has almost double the strength of gray iron and an elongation of about 8 per cent as compared to no elongation in the gray iron.

Third.—Malleable castings can easily be supplied to equal this grade of cast steel in all physical tests, and to surpass it so far as smooth surface is concerned. And at the same time the malleable castings will show a superior machinability according to the operation, ranging up to that shown in the drilling test where repeated tests on cast steel showed that it required about four times as long to machine cast steel as malleable of similar physical properties and characteristics as nearly as a comparison might be drawn.

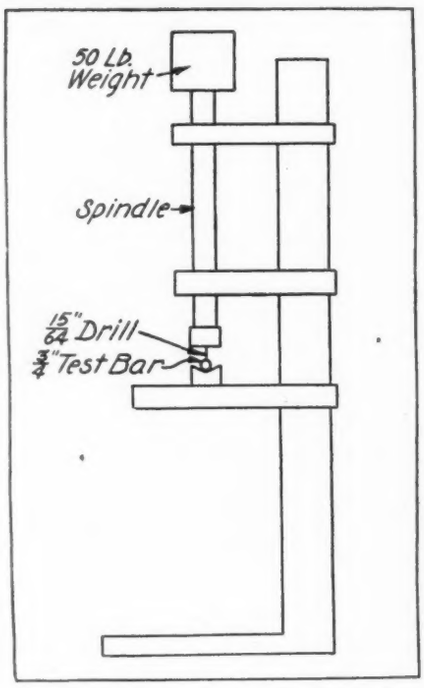


FIG. 2—APPARATUS FOR DRILLING TEST

Hard Spots in Castings

By H. E. Diller

Question:—Small castings, under a pound in weight, which we make, frequently have hard, white spots around the edges. The analysis of our iron averages: Silicon, 3.22 per cent; sulphur, 0.050 per cent; phosphorus, 0.74 per cent; manganese, 0.87 per cent. We would like to know the cause.

Answer:—The hard, white spots at the edges of your castings were probably caused by wet sand which chilled the metal at the places which were white. In a similar case it was found that the molder was swabbing the corners of the molds with water to prevent the edges from breaking.

High silicon irons such as you are melting are particularly subject to chilling under these circumstances. We would recommend that you run the silicon in your metal between 2.25 and 2.50 per cent and guard against moisture.

Elimination of Strains in Castings

BY C. J. WILTSHIRE

IT IS a well known fact that appreciable strains which are caused by unequal radiation of heat from the castings after they are poured remain in iron castings after cooling. This unequal radiation is due to variation of section and difference in length of paths through which the heat must pass to escape from inner to outer surfaces. In consequence the heat is not uniformly dissipated. The portions where the metal is thickest and also those most remote from the point of heat exit, retain their temperature longest, and as result, shrinkage strains are set up in the parts which cooled first.

Some 22 years ago, Alexander Outerbridge, of Philadelphia, discovered that vibration of a cast iron bar (by tumbling in a barrel or by a continued tapping with a hammer) would invariably increase the strength of the casting. The theory of this treatment is that the action of cooling causes molecules of iron to be held in tension which is relieved when the casting is subjected to vibration.

It has since been found that this tension can be relieved by annealing the castings in an oven of moderate temperature. It is the purpose of this paper to describe the method.

That shrinkage strains exist in most castings is demonstrated by the fact that if a plain cast-iron plate be machined to a true surface on one side, the operation of machining the other side will frequently disturb the accuracy of the surface first finished. This phase of the matter was presented to the American Foundrymen's association in a paper on "The Seasoning of Gray-Iron Castings," by L. M. Sherwin, of Brown & Sharpe Mfg. Co., at the Boston meeting in 1917, and later published in the October, 1917 issue of THE FOUNDRY.

Large castings which have been left in the sand to cool off slowly and then finished to true dimension, have been found distorted under ordinary temperature changes, after a few days, but these same castings after treatment in the oven did not show any change whatever.

Other castings which have been finished and put under steam for test have shown considerable distortion when taken apart, while castings from same patterns when treated in an oven before finishing and tested out in the same way, showed no change.

Again, large castings which have been finished and lined up as parts of a large unit, have shown sufficient distortion to cause parts of the machine to become out of line after a number of months in service. Such castings are now being annealed and from results obtained it is believed that this treatment will prevent the defects experienced.

The method of treatment is as follows:

The castings are placed in the oven, the doors are closed, the heat turned on, and the temperature raised to 700 degrees Fahr., which generally takes from seven to eight hours. This temperature is held for an additional seven hours, when the heat is shut off and oven is allowed to cool down slowly for approximately 20 hours, with a resulting temperature of about 300 degrees Fahr. The oven doors are then opened and temperature is allowed to drop to approximately 150 degrees Fahr., when the castings are in shape to be taken out. The entire operation consumes about 48 hours.

The ovens are heated with oil and the amount of oil per ton of castings treated has averaged 9.6 gallons. Each heat required 284 gallons of oil and approximately 29 tons of castings were treated each heat.

A paper presented at the Philadelphia meeting of the American Foundrymen's association, Sept. 29-Oct. 3. The author, C. J. Wiltshire, is foundry superintendent, General Electric Co., Schnectady, N. Y.

Sulphur Reduced in Malleable Iron

Cupola Metal Refined in the Electric Furnace—Sulphur is Lowered by a Reducing Slag Containing Calcium Carbide—Advantages of Such a Duplexing Process are Considered

BY A. W. MERRICK

THE American or blackheart malleable cast iron produced in this country is usually melted in air (or reverberatory) open-hearth or cupola furnaces. Either of these types of furnaces offer certain inherent advantages and disadvantages, but as it is with the last named that we are to deal in this paper, the discussion will be limited to this one method of melting.

Its advantages are briefly as follows: Low initial investment; low cost of operation, upkeep and repairs; intermittent or continuous operation which gives a great flexibility of capacity; high melting ratio of iron to fuel, and ability to melt high percentages of cast iron and steel scrap without the consequent lowering of the carbon content which would necessarily follow in either of the other two types of furnaces. From the foregoing it will be seen that the cupola will produce molten cast-iron at the spout cheaper than any other type of furnace, and this fact is universally conceded by all authorities.

FIG. 1—RESULTS OBTAINED WITH TEST WEDGES OF LOW MANGANESE IRON

There are, however, certain disadvantages in cupola melting as applied to cast iron in general and malleable cast iron in particular. First, the sulphur absorbed from fuel is higher with this process than either of the others. Secondly, it is not possible to produce an iron of a low carbon content, which with malleable iron limits one to the production of casting of very light section. This is due to the fact that the melting stock, being in intimate contact with the incandescent carbon of the fuel, absorbs carbon so readily, that with the constant silicon aimed for in malleable iron, a practically saturated condition is reached so that with other conditions equal, the carbon is never very far either above or below a fixed point. This holds good even where the percentage of steel in the charge is varied considerably. Thirdly, cupola iron, especially on long heats, is liable to quite a variation in temperature and composition. The latter evil is especially aggravating in malleable work where the importance of keeping the two elements sulphur and manganese, in a proper relationship is well recognized.

In order to overcome these last two disadvantages we might utilize some sort of a mixer that would act as a reservoir and by holding a given quantity of metal allow it to become constant in temperature and composition. The difficulty with this plan, is of course, that the temperature of the molten metal would be constantly lowering unless some external source of heat were applied, so that the question narrows itself down to just what this source of heat would be. The electric furnace, at once suggests itself as ideal, for in addition to supplying the heat needed, it will also allow the removal of the greater part of the sulphur by use of a proper slag. Not only this, but it will, in addition, allow an iron of any carbon content to be made by the means of additions of either cold or liquid steel, so that compositions of any range of carbon and silicon can be made and any castings of sections practicable in malleable iron may be poured. The advantages of such a duplex process are readily apparent to anyone familiar with the production of cupola malleable iron. Cupola iron is especially suitable for castings of light section, such as pipe fittings, etc. In the latter case where an iron high in carbon is desirable, because of the greater ease of threading the fittings this process should recommend itself immediately. In addition to the advantages previously enumerated it would permit the annealing of the white iron at a considerably lower temperature than is practicable with a high sulphur iron, such as is ordinarily produced in the cupola.

In order to determine how far it is possible to reduce the sulphur in cupola iron in a reasonable length of time by this process, some sprues and scrap were obtained from a manufacturer of cupola malleable iron and melted in a small Heroult electric furnace. The material had the following composition: Silicon, 0.65 per cent; manganese, 0.53 per cent; phosphorus, 0.143 per cent; sulphur, 0.20 per cent, and carbon, 3.06 per cent. This analysis was supplied by the firm which furnished the scrap and was given as the average. No attempt

Paper presented by A. W. Merrick at the annual convention of the American Foundrymen's association held in Philadelphia, Sept. 29-Oct. 3.

The author is metallurgical engineer in the research laboratory of the General Electric Co., Schenectady, N. Y.

was made to check it due to the difficulty of securing an average sample of material of this nature.

The scrap was melted bare in the furnace and then a basic slag of lime thinned with spar was put on. Finely ground petroleum coke was sprinkled over the slag to reduce all oxides throwing the metals back into the bath, the slag turning a creamy white color, indicating the completeness of these reactions. Calcium carbide is formed in the slag as is evidenced by the pronounced odor of acetylene when such a slag is moistened in water. A slag of this character will readily absorb sulphur from the bath and while the reactions require some time for completion, the practical elimination of the sulphur is very rapid.

Accordingly, 15 minutes after the slag was made a sample was taken for analysis, with the following results: Silicon, 0.57 per cent; manganese, 0.54 per cent; sulphur, 0.057 per cent; and carbon, 3.36 per cent.

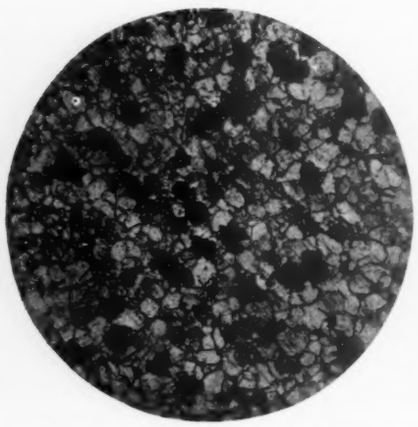


FIG. 2—STRUCTURE OF CENTER OF TEST BAR

Note the reduction of sulphur which is very striking when it is considered that the sample was taken just 15 minutes after the formation of the slag. There is something further of note, namely the retention of the manganese. This element is readily oxidized in the cupola and it is customary to run the mixtures very high in manganese to take care of what is burnt out in melting and still leave enough for the high sulphur that is obtained. With the electric furnace, no speigeleisen, ferromanganese, or high manganese pig is necessary, and in fact, as will be later shown, the mixtures, to get best results, would have to be kept low in this element. As was mentioned before, the analysis before melting was supposed to represent the average so that the slight difference of silicon obtained need not be considered. The carbon, however, seems to have increased, but there is a possibility of doubt here, as 3.06 per cent seems rather low for cupola iron in the first place. Then again, when carrying a refining slag on low carbon steel, which is greedy for carbon, the increase due to additions of coke to the slag are so small as to be negligible.

At the same time the sample was poured for analysis, a set of test bars was poured and after cooling the bars were broken and fractures examined. The bar 5/8-inch in diameter was clear white and the 1¼-inch bar nicely mottled so that the composition seemed all right for the class of material under consideration. A set of test bars and wedges for annealing was then poured.

In order to obtain iron more suitable for work of a heavier section, some steel and ferrosilicon in calculated amounts were added to the bath. The calculation was based on the 3.08 per cent of carbon as supposed to have been in the original material but as it was actually higher in carbon the result was higher than desired. However, it was near enough for the purpose, to illustrate the possibility of producing an iron of a lower carbon than is ordinarily obtained in the cupola. The actual analysis is given as follows: Silicon, 0.75 per cent; manganese, 0.53 per cent; sulphur, 0.036 per cent; and carbon, 2.90 per cent.

Slag Lowers Sulphur

It is interesting to note in passing that the analysis obtained was exactly that expected, taking into consideration the actual first analysis, and the analysis and amounts of the additions. Anyone who has had experience in adding ferrosilicon to an air furnace where a strongly oxidizing condition prevails, to bring up the silicon, can appreciate this. The sulphur is still lower in this sample, which can be attributed to the further refining of the slag, for even had the steel contained no sulphur the resultant would have only been 0.045 per cent, had the slag not absorbed more from the bath.

Test bars of this composition were poured and both sets of bars were subsequently sent to the firm that supplied the scrap for annealing. They were packed in the second pot from the bottom and placed in about the middle of the oven.

The examination of the bars after annealing showed that the metal was inclined to be rather "short" and that it lacked toughness. This might easily be expected when the high manganese, low sulphur composition is taken into consideration. The fractures viewed with the eye looked like typical blackheart iron with the exception that the rim of ferrite is heavier than usual. Under the microscope, however, we find that the structure consists of a rim of ferrite and the interior a matrix of ferrite and pearlite embedded with temper carbon, instead of a pure ferrite matrix, characteristic of good blackheart iron.

As it was impossible to obtain any low manganese, high sulphur cupola iron without making it especially for our purpose, a mixture of gray scrap, washed metal and steel was melted to give a composition approximately that obtained by refining a cupola iron high in sulphur but low in manganese. Bars were cast from this heat as previously and annealed. The composition was similar to the first lot prepared except that the manganese was 0.14 per cent and the sulphur 0.009 per cent. In this case where the sulphur was low to start with, it had practically been eliminated by the action of the slag in the furnace.

These bars after annealing were quite a lot better than those first prepared, containing manganese over 0.50 per cent. The test wedges could be curled up more, as is shown in Fig. 1. The tensile strength of this composition is from 38,000 to 40,000 pounds, but the elongation in 2 inches is only 3.5 per cent. The molding was bad and these were very defective looking bars. The bars when polished and etched, showed an improved structure over the first set but still showed some pearlite in the rim, although the center of the bar showed the typical blackheart structure. This is shown in the photomicrographs, Figs. 2 and 3.

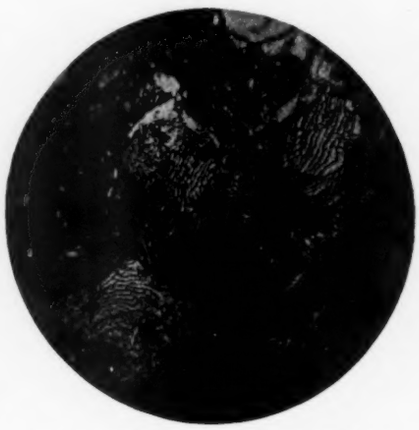


FIG. 3—STRUCTURE OF RIM OF TEST BAR

The conclusion to be drawn from this result is that evidently there is still too great an excess of manganese present for the low sulphur and some further work is planned to verify this.

Among the conclusions which the author arrived at are the following:

1—The cupola is the cheapest method for producing molten cast iron.

but the process has several inherent disadvantages that have limited the use of cupola malleable to work of light sections. It produces iron high in sulphur, and variable temperature and composition.

2—The electric furnace is capable of refining this iron, reducing the sulphur to a negligible amount and superheating the metal to any desired degree without any further altering of composition.

3—Such a process as described will permit iron of any carbon and silicon desired to be made by the proper additions of steel and ferrosilicon.

4—Where this duplex process is used, the amount of scrap used in the cupola can be increased and the fuel decreased as it would not be necessary to have the iron as hot as is the practice when poured direct into the molds.

5—The mixtures would have to be kept low in manganese, no high manganese pig or spiegeleisen would be used and it is believed that by using low manganese scrap that the amount of manganese burned out in the cupola would lower this element to the point desired. This will have to be worked out definitely in the future from further experimental data

6—As to costs, no figures can be given as the process is not believed to be in operation as specifically outlined in this paper. However, the power required ought not be more than 150 to 200 kilowatt hours per ton on molten metal from the cupola and with continuous operation, the labor charges should not be excessive. These costs would be offset by the lower cost of melting stock, reduced amount of coke used in melting and the lower temperature of the annealing ovens for the annealing of such low sulphur iron.

Electric Furnace an Adjunct to Cupola

THE advantages of a duplex process using the electric furnace as an adjunct to the cupola for melting gray iron were outlined by George K. Elliott in a paper presented at the annual convention of the American Foundrymen's association held in Philadelphia, Sept. 29-Oct. 3. The author called attention to the fact that while the cupola is an efficient furnace for melting iron it has certain limitations which prevent it from furnishing an iron which entirely meets the requirements for certain classes of castings. But for the ordinary run of iron castings, comprising possibly 90 per cent of the total output of the country there was said to be no valid economical reason for either displacing or radically modifying the modern cupola.

The author goes on to say that whatever its faults may be, it must be acknowledged that for preheating iron up to the point of melting, and after that performing the fusion itself with a minimum waste of heat, the cupola stands supreme among the established foundry furnaces. Its melting efficiency approximately is 40 per cent although in the hands of the unskilled it may fall as low as 25 per cent, while the adept may drive it along at a rate of as high as 50 per cent efficiency. Although the cupola is practically without rival as a preheater and melter it does not attain the same high rank as a superheater of molten metal. The cupola operator's problem in obtaining superheated iron is largely one of circumventing terrestrial gravitation as it is manifested in the speedy dripping of the molten iron through and away from the hottest zone of the cupola.

In the two-step process that has been described, all responsibility for superheating is taken from the cupola and assigned to the electric furnace, where with the greatest ease it can be superheated to a degree that is not possible in any other kind of furnace. Superheating in the electric furnace enables the foundryman to make castings of low-phosphorus iron which otherwise it would be necessary to make of high-phosphorus iron, because he can safely shift the responsibility for fluidity from the material to the furnace.

Another advantage, and by no means a minor one, is that hot iron tends to increase solidity in castings. By solidity is meant not only closeness of grain but freedom from internal imperfections such as blowholes, shrink-holes, slag inclusions, graphite segregations, and similar defects.

Refining Agents

The process of treating iron in the cupola cannot be extended beyond the point of melting and a certain limited amount of superheating. Any additional operation such as refining, is entirely out of the question and can be performed only in some other kind of furnace. In considering the electric furnace in relation to refining it is preferable to consider separately the acid-lined and the basic-lined furnaces. The acid-lined furnace refines entirely through maintaining a constant reducing atmosphere in contact with the metal. The refining in an acid furnace is one of deoxidation coupled with a freeing of the bath from included gases and slag.

One must turn to the basic-bottom electric furnace to find potentiality in refining at its greatest. Almost any metallurgical reaction may be conducted in it, including oxidation, reduction, dephosphorization, desulphurization, decarburization, carburization, mixing with ferroalloys, superheating, and others. The duplex process for cast iron is chiefly concerned with reduction, desulphurization and mixing.

Standard pig iron containing a maximum of 0.05 per cent, sulphur contains from 0.07 to 0.11 per cent after coming from the cupola, the degree of contamination depending upon the quality of coke, the condition of the cupola and its accessories, and the skill and knowledge of the cupola tender. The same iron from the cupola may subsequently have its sulphur reduced to about one-third or one-fourth by 30 or 40 minutes refining in a basic bottom electric furnace. The average of a great number of *duplexed* heats of gray iron was .088 per cent sulphur in the melt from the cupola, while in the final product from the electric furnace the average was 0.036 per cent. As low as 0.009 per cent sulphur in occasional heats has been produced in gray iron under everyday working conditions.

The electric furnace step of the duplex process is particularly good for mixing. It enables a perfect mixing of the original raw materials, assuring homogeneity in the single heat, and it facilitates the accurate duplication of results, assuring uniformity among several heats. It also simplifies and insures the perfect admixing of alloys such as ferrosilicon and ferromanganese. The electric furnace allows steel scrap to be mixed with the iron and by this means the amount of total carbon in the metal can be controlled, while when steel scrap is mixed with iron in the cupola an indefinite amount of carbon is taken up from the coke.

Educational Value of a Scrap Pile

Defective Castings Are Not Altogether Without Value if They Suggest to the Foundryman's Mind a Method for Prevention of Trouble in the Future—Where Study is Needed

BY HENRY TRAPHAGEN

DEFECTIVE castings—the tenants of the scrap pile—offer to the discerning and ambitious foundryman knowledge that is beyond price. Show the foundry expert the scrap pile, and he will tell you the caliber of the foundry, for evidence of either constructive progress or the senseless repetition of blind ignorance, is indelibly and relentlessly stamped on that tell-tale pile of rusting iron.

It all depends upon whether the defective castings are intelligently examined or are buried away under old barrels, what the real value of the scrap pile will be to the foundry. Intelligently examined and constructively criticized, a defective casting will invarably point out the antidote; but if it is hidden away and treated as an enemy it means that casting after casting will be turned out in the same old way; the customer will be dissatisfied; the foundryman will make no progress; and the establishment itself will finally rest in the financial scrap heap.

The up-to date foundry should have at least one competent, experimental molder, paid by the day, and not hurried; his business would be to investigate the proper method of gating and heading castings as they come into the shop. Every department should be interested, every responsible department head should lend his bit to the fund of general knowledge. The work of the experimental molder should be thoroughly examined, and discussed. If consistent and concentrated effort is made, it will be but a short time before the experimental molder turns out a sound casting.

He May Go to China

When the casting comes right it should be either sketched or photographed with the gates and heads attached, and a permanent record made. If the same job comes back a year or two later it is immaterial whether the experimental molder is in China or the superintendent in parts unknown—that casting can be made again, for the proper method of making it is on record.

It would appear at first sight that experimental molding would be an almost endless task; that the experimental molder would have to start out on an entirely new tack every time a casting came into the shop, and that the number of records necessary would be almost overwhelming, but if foundrymen will carefully investigate this method of experimental work, they will find that after all, the number of real basic defects that are found in castings are comparatively few. They will discover that castings naturally group themselves into a few well defined classes, and that each class is subject to characteristic defects that are easily recognized, and in a short time they will learn to discount possible defects at the start.

If the foundryman can grasp the broad conception of castings as a whole; if he can master the few fundamental laws of solidifying metal, he will have made no small measure of progress toward the desired end. But unfortunately, it seems to be the common impression that the various branches of iron and steel founding are each peculiar to themselves; for instance, the malleable man imagines that his troubles are quite distinct from those found in the gray iron shop; while the gray iron founder is under the impression that gray iron and semisteel obey laws that were designed especially for them; and it is sometimes amusing to hear the steel man dilate upon the peculiar and mysterious troubles of the steel business.

Literature Deficient

Now if the foundryman will only recognize the fact that all these various metals are alloys of carbon and iron; that they all merge into each other without any sharp line of distinction; and furthermore, that they all in general obey the same laws, then, a great light will dawn upon him and he will realize that there are but few real basic troubles in a foundry.

Several fundamental difficulties that are found in foundries have been described in the literature on the subject; but unfortunately these descriptions seem to be lost in a maze of words dealing with the various peculiarities of chemical ingredients, new fangled methods of chemical analysis, long discussions on grain aggregates, and in fact, everything under the sun, except a frank, plain discussion of the foundryman's troubles. It is because of the great difficulties in wading through a mass of literature that the average foundryman has become disgusted with chemists and scientists in general; and judging from the impractical, high-brow contributions that they have given later-day literature, it

Scrap Tells the Tale

THE size and composition of the domestic scrap pile in the foundry yard is a fair indication of the success or failure of the methods in vogue for producing castings. One way to reduce casting losses is to have all new work pass through the hands of a highly competent molder. He should be allowed to experiment until he has arrived at the one best way of making each piece. With a satisfactory method once established, a photographic record should be made showing all the important details. Having this record it would be perfectly immaterial whether the personnel of the foundry changed or not. The records would always be available for whoever needed them.

While it is true that the great majority of castings are lost through some fault in the molding practice, it is equally true that a sufficient number are lost through metallurgical faults to warrant the utmost vigilance on the part of the foundryman, both in buying his iron, and later, in melting it.

Some iron is fundamentally bad and will never produce satisfactory castings. An off heat of pig iron, due to one of a variety of causes which interrupt the even working of a blast furnace, is in this class. So is thin, rusty sheet scrap. Rust is oxide of iron and during the melting process it enters the metal and becomes emulsified. No amount of flux, deoxidizer or cleansing agent will get it out. Suspended oxide is responsible for the rejection of many castings, more especially those which have to undergo pressure tests.

From a paper presented at the twenty-fourth annual convention of the American Foundrymen's association held at Philadelphia. The author, Henry Traphagen, is metallurgist for the Toledo Steel Casting Co., Toledo, O.

would appear that the foundryman's disgust is well founded.

If the foundryman will carefully study his defective castings the writer believes that he will ultimately agree that all of the defectives can be traced to one of a very few fundamental errors. In general, these fundamental errors may be summed up as follows:

First.—The personal equation, or in other words, the carelessness of the workman.

Second.—Over-production, which puts a premium on careless, sloppy work.

Third.—The attempt to make good material out of junk.

Fourth.—False economy, which results from the use of too little fuel, too much scrap, cheap refractories and too great a reliance in green sand molding practice.

It has been the writer's experience that about 10 per cent of all troubles in the foundry can be traced to the melting department and the other 90 per cent to the molding department.

To produce a good casting from any kind of iron or steel, it is absolutely essential that the metal be hot and fluid. But unfortunately, hot, lively metal is not as common in our foundries as one would be led to expect, and the causes of cold metal may be briefly summarized as follows: The bed in the cupola may be too low. This is a very common error and generally results in cold, sluggish metal. It is a simple matter to determine whether or not the bed is low. Leave the tap hole open, turn on the blast, and note the time that it takes for the first metal to run over the spout. If iron appears in less than 10 minutes, it is almost a certainty that the bed is too low. A low bed means dirty, porous, weak castings, owing to the metal melting directly in front of the tuyere blast and becoming unduly oxidized.

Correct Melting Ratio

Another prolific source of cold metal lies in the attempt to conform to a prearranged melting ratio. In the dictionary of common sense there is no such term as melting ratio. The correct melting ratio is the amount of coke that will give hot, fluid metal; and this amount of coke will vary with the size of the cupola, the amount of scrap used, the kind of coke, the percentage of steel used in the mixtures, and the size and condition of the sprues. It is therefore evident that it is ridiculous for anyone to attempt to lay down a specific melting ratio for cupola practice.

Cold metal in the converter can generally be laid to one or two causes. The metal from the cupola may be cold for one of the reasons just enumerated; the percentage of silicon may be too low for successful blowing, or what is most common, the lining of the converter may be too wet, or there may be a leak in the wind chest or somewhere along the line. It is rarely found that cold metal can be traced to a variation in chemical content, and before the foundryman wastes any time fooling around the laboratory, it is far better for him to examine his cupola practice, his converter linings and his wind apparatus.

Another Cause for Cold Metal

There is another great fundamental cause for cold iron, it is found not only in the cupola, but in the converter, the air furnace, the open-hearth furnace, the crucible furnace and even in the electric furnace.

Reference is made to the effects of oxygen, which causes oxidized metal. There is no disputing the fact that foundries very frequently receive shipments of pig iron that will not produce hot iron, no matter how careful the melting practice may be, and such iron is delivered much more frequently than the average foundryman is aware of. It is useless to check up the analyses of such material, for the blast furnace laboratory report will in nearly every case be correct, and the fact that it is correct furnishes the chief alibi for the furnace.

Pig iron is sold on chemical analysis only, and it is presumed that if the analysis conforms to the customer's requirements the iron must necessarily be satisfactory, but nothing, in my judgment, is further from the truth. The pig iron that generally causes such a long train of disagreeable troubles, such as porous castings, skulled ladles, bunged-up cupolas, etc., is a product of over-production.

If, on breaking a shipment of iron it is found to be consistently unsound and full of gas cavities, reject that iron if it is possible to do so. But if the furnace absolutely refuses to take such iron back, which is too often the case, then the only course left to the foundryman is to hold the shipment in the yard and use it very gradually, say one pig to a charge, until the pile is gone.

The writer has found defective pig iron in practically every kind of a foundry including malleable iron, gray iron and steel plants.

Another source of cold, sluggish iron and steel lies in the use of thin, dirty, rusty scrap. Such material as rusty flashings, turnings, shearings, punchings and other fine voluminous scrap should have no place in the melting furnace, if the melter expects to get sound, healthy metal. Such scrap is being used literally by thousands of tons in our open-hearth furnaces today. It is common in steel foundries, malleable shops and gray iron foundries. But the result is the same, no matter what type of furnace is being used or what kind of product is being manufactured.

Rust is an oxide of iron, and it is finely divided. During the melting process this rust or oxide enters the metal and becomes emulsified. And no amount of fluxes, deoxidizers, or other cleansing agents will get it out. I believe suspended oxides in metal are causing more trouble today in the iron and steel industry than any other one thing. The use of such material is directly at variance with all the sound principles of metallurgy. How long the manufacturers will use this material and how long the consumer will continue to receive such metal is a problem. But the light is breaking and the day of reckoning for the iron and steel manufacturers who attempt to melt up nothing but junk, is close at hand.

Cold metal is distinctly a problem for the melting department, but it effects the molding department so strongly that the molder must take it into consideration. It is a well known fact that the moment molten metal strikes the sand a large volume of gas is generated. This gas is formed from the decomposition of binding materials, but most of it comes from the water that is in the sand.

If such gas is not allowed free exit, it is going to be trapped in the metal, the colder the metal is the more quickly it will set, and the more likely it is that the gas will be trapped under a frozen skin.

How many times does a foundry turn out what is apparently a perfect casting only to have it rejected in the machine shop just as soon as the first cut is taken from the cope side. The gas trying to escape has been trapped just below the surface because the metal has set too quickly to allow the gas to get away; this is a very common defect in green-sand molding; hence the necessity when attempting to make green-sand work, of having the metal very hot and fluid and venting not only the cope but the drag, and making sure that the vents in the cores are wide open

The Sins of the Cover Core

An interesting sidelight in connection with this discussion is the question of using oil-sand cover cores. It is a very common occurrence to find a casting made under a thick, hard oil sand cover core, with absolutely no provision for the escape of gas. The foundryman struggles along and probably gets two out of 10 castings, whereas if he would merely puncture

the cover core with three or four pop heads and let the gas out, the probabilities are that all of the castings would come good.

The question of shrink heads or risers is one that is given too little consideration in the foundry. A head to be of any value, must be large enough in cross section to remain open until the casting has set. It is well to remember that probably not over 30 per cent of the cross section of a head is available for feeding and this statement applies with more than ordinary force to the neck of the feeder; it is folly to make a great big head and then neck it down so narrow that the neck freezes almost instantly, and it is equally futile to expect a head to feed if it is not placed squarely upon the casting. How often does one find a head with a neck say 2½ or 3 inches in diameter about one-fourth of which is attached to the casting and the rest wandering off in space.

The common practice of taking an old splintered block of wood, sticking it to the pattern with a nail, and attempting to make an efficient head is the falsest of false economy. A foundry should have a stock of standard heads carefully made in the pattern shop and fitted with dowel pins so that they can be set squarely upon the pattern with little danger of being misplaced.

Welders Work Overtime

There is a tendency among foundrymen of the present day to skimp on heads. They love to talk about their very low sprue returns but they neglect to state that the welder works overtime every night. Molten metal will shrink as it cools and that shrinkage must be taken up either by overhead feeding or internal chilling, and when a foundryman tries to tell you that his castings are sound without any kind of feeding, that man is trying to change the laws of nature, and personally I cannot see how he expects to get away with it.

Another important point is the part that water plays in the foundry. There is probably no other one factor with the possible exception of oxygen, that has so much to do with the success or failure of a foundry. Consider for a moment some of the troubles directly traceable to the old H_2O. In the cupola for instance, we have the well known rubber bottom arising from wet bottom sand; we have cold metal and slow melting from wet coke, wet iron, and moisture-laden air. In the converter we have wild heats, cold metal and cut linings. We find pin holes in the castings due to the metal boiling on the surface of a wet mold; we have entrapped gas and dirt, because too much water in the facing and heap sand has frozen the metal prematurely.

A casting may look sound, but millions of tiny bubbles of exploding steam have made it porous so that it will not stand up under gas or water pressure. All over the country foundries are making hydraulic and ammonia castings by the green-sand method; and they are stoutly claiming the fact that they are getting away with it. Careful investigation, however, will prove that the consumer is kept busy closing up porosities and every so often a truck load of defective castings is brought back to the foundry and is carefully smuggled in the back door, so too many people won't see them. It is possible to make hydraulic castings in green sand molds, but it is not possible to make them day in and day out and be fairly certain that they are all sound. It is almost an impossibility to control the water in the green sand mold; and water suddenly converted into steam has a habit of exploding in the most unforeseen places and in the most peculiar ways. As a general rule, a hydraulic or gas casting should be made in a thoroughly baked mold, and if proper materials are used, and the melting is carefully done and the mold is kept clean, there is no trick in turning out acceptable hydraulic castings.

There is one more item in the molding department that deserves attention and that is the proper method of pouring. The scrap pile receives a great many contributions because of the carelessness or incompetency of the man at the ladle. Every ladle of metal should be held for a minute or two to allow the slag and other impurities to come to the surface. Stopping to allow the metal to clear itself may seem like a waste of time to the modern production hog, but if the gentleman will stand by a ladle and watch the various impurities float up to the surface he will understand why it pays to give the metal time to clear. In the end more good castings will accrue from such practice, and in the final analysis real production will be increased. Metal going into a sand mold should be poured evenly and carefully and under no consideration should hot metal be poured at high pressure directly over a large flat area of sand. Cuts and scabs and snakes are too often the result of fast, furious pouring. It is far better when dealing with a casting having a large flat surface, to cut back-up gates and break the force of the stream of metal rather than resort to a mass of finishing nails, a lot of swabbing and other dodges to prevent the facing from cutting.

Another exceedingly common error is the practice of pouring metal at right angles directly up against a core. If it is possible to allow the metal to slide parallel to the core, there will be far less cutting and much less dirt.

It is obviously impossible for any one man or group of men to enumerate, much less describe, the many apparent defects and troubles that exist in a foundry. If the foundryman will carefully study and examine the defective castings, if he will try to trace out his problems from cause to effect rather than trust to dumb luck, he will find, as stated before, that the real fundamental troubles in the foundry are comparatively few.

The value of a scrap pile lies in the fact that it offers a real course of instruction in foundry practice, and this paper has been written in an attempt to induce the foundryman to commune with his defectives, to study their peculiarities, to grasp the principles of casting in their broadest sense, to realize his responsibility to the community, and finally, it is written with the hope that the foundryman will earnestly strive to manufacture sound castings, rather than alibis and fictitious production sheets.

Show Precipitation Model

A model illustrating the operation of the Cotrell precipitation process for removing flue dust from blast furnace gases was exhibited at the Chemical Exposition in the Coliseum, Chicago, Sept. 22 to 27. This model was made by the General Electric Co., Schenectady, and was shown under personal supervision of Chester T. McLoughlin assisted by Raymond Barclay, both of the General Electric organization.

Training Workers

Training bulletin No. 24, entitled "Industrial Training for Foundry Workers" has been published by the United States department of labor, United States training service, and will be forwarded to any person interested by applying to C. T. Clayton, director, Washington. This report was issued in preliminary form some time ago and published in the July 15 issue of THE FOUNDRY.

The Worthington Pump & Machinery Corp. has taken over the Epping-Carpenter Pump Co., Pittsburgh, the plant of which will be known as the Epping-Carpenter works of the Worthington Pump & Machinery Corp.

Plea for Less Rigid Sulphur Limits

Usual Requirements Regarding Sulphur in Specifications for Cast Steel are Considered too Exacting—Molding, Steelmaking and Annealing Practices are Said to Affect the Casting More Than Somewhat Higher Sulphur Content

BY A. E. WHITE

IT is not the object of this paper to add any new evidence to that which already has been presented. There has been no opportunity, since the writer was requested to prepare a paper on this subject, to make experiments and tests. It is the object of the paper to plead for a thorough survey of the items which affect the quality of steel castings and to judge of their acceptability on the basis of the properties they possess rather than to lay undue emphasis on one or more disputed points.

Considerable has been written concerning the effect of sulphur in steel. Numerous writers have pointed out that sulphur in percentages much above 0.04 or 0.05 gives material showing undesirable qualities. Now and then some one suggests that sulphur in percentages greater than 0.04 or 0.05, possibly as high as twice the values given, in no way affects the quality of the steel. Much that has been written is in the way of exposition and is not supported with evidence. Furthermore, a considerable amount of the evidence submitted is so beclouded by other factors that the data is valueless. Practically all of the literature discussing sulphur deals with its influence in rolled or forged steel and not in cast steel. Between cast steel on the one hand and rolled or forged steel on the other, there is, in the writer's opinion, a vast deal of difference. Therefore the observations on the influence of sulphur in rolled or forged steel, relatively speaking, may have little bearing if applied to cast steel. This, briefly stated, is the status of the question at the present time.

Factors Affecting Quality

Broadly speaking, there are five main factors which affect the quality of steel castings. These are design of castings, composition, molding practice, steelmaking practice and annealing practice.

Included in the molding practice may be listed the kind of mold, whether of green or dry sand; method of venting; weight and location of riser; method of gating; character of cores; length of time mold is kept around metal after pouring, etc.

In the steelmaking practice may be included place of recarbonization, whether in furnace, converter or ladle; size of heat; number of castings to be poured from a given ladle; temperature of pouring, etc.

In the annealing practice may be included the evenness of furnace temperature; the temperature employed; the time consumed in bringing to heat; the time at heat; the time consumed in cooling; the type of castings placed in a given furnace, whether all light, all heavy, or mixed; the type of furnace used, whether a furnace designed for heavy castings employed on light ones or vice versa; character of flame, whether oxidizing, reducing or neutral; etc.

There are times when too little attention is given to the question of design of steel castings. Many designs are made by men who know too little about the characteristics of metal when it is changing from a liquid to a solid. Much improvement in the matter of quality of finished castings could be brought about by closer co-operation between the designer and foundryman, and it is trusted that as time goes on, this suggested closer co-operation will become more and more common.

Purchaser's Inspection

In general, the steelmaking and molding practice is of an acceptable character. In large measure, however, the purchaser is in the hands of the founder since it is not feasible for him to employ as expert a steelmaker or steel founder as the steel-casting operator can afford to do, and only by the employment of an abler steelmaker or founder can he expect to properly pass upon these phases of the process. Even if he can get a man of suitable experience, it is questionable if he should employ him, for by so doing, a status of divided authority in the steel castings plant would develop, and such a condition would be most unsatisfactory and in fact, quite impossible. Also, by chemical, physical and visual tests the purchaser can gather sufficient information regarding the character of the castings to decide whether or not they are acceptable, so that he is not as much at the mercy of the founder as might appear to be the case at first glance.

The writer believes much greater attention should be given to the matter of annealing, in the future, than has been accorded it in the past. As a rule, steel founders have not awakened to the latent possibilities of scientifically controlled annealing. Many furnaces bear indications that the only things thought of in their design are walls, a floor, a roof, and some kind of ports for the admission of heat.

Irregularity in Annealing

There seems to be an utter disregard of such questions as fuel efficiency, through proper combustion and control of heat losses by radiation and by the stack; character of the flame, whether oxidizing, reducing or neutral; scientific temperature control, for in most furnaces there is as much as 200 degrees Fahr. difference in temperature in different portions of the same furnace; accurate temperature measurements, for such furnaces as have pyrometers usually have only one and it is neither frequently calibrated nor does it necessarily record the real conditions in the furnace because of the varying temperature distribution in the same; and care in the selection of only pieces of approximately the same cross section for each furnace per anneal, for there exists a more or less haphazard method of placing castings with different cross sections in the same furnace with the resultant of either overheating the thin ones or failing to remove the dendritic structure in the thick ones.

It was the writer's privilege in the fall of 1916 and the winter of 1916-1917 to visit nearly all of the important steel casting plants in the eastern half of the United States. It was also his privilege to have under his supervision the inspection of all the steel casting plants producing ordnance material for the United States army from January, 1918, until he left the service in March, 1919. As a result of this experience, he has come to feel to a greater and greater extent that the acceptance of steel castings should be placed on a broad basis and that the minute scrutiny of castings for a few hundredths of a

Paper presented by A. E. White at the Annual convention of the American Foundrymen's association held in Philadelphia, Sept. 29-Oct. 3. The author is a prominent member of the engineering faculty at the University of Michigan, Ann Arbor, Mich., and during the war was an officer in the ordnance department, where he had charge of steel foundry operations.

per cent of sulphur is both irrational and unwise.

To talk about the effect of an increase of 0.01 or 0.02 per cent of sulphur when by improper annealing, improper steelmaking or by improper foundry practice, properties many times worse than those produced by sulphur are acquired by the steel, is, in the writer's judgment, placing undue emphasis on the wrong factor.

Sulphur in steel may increase blow holes—it is granted that this is a disputed point—but assuming that it does, it will not do so to nearly the same extent as an improper temper to the mold; improper venting of the mold or core, especially the core; or an improper pouring temperature. It may increase shrinkage, but it will not do it nearly as much as an improper casting design, an improper pouring temperature, or too rapid a heating or cooling during the annealing. It may decrease the metal's resistance to shock but not to the degree that a poorly designed casting will, or one in which the metal has been overheated, burned or underannealed with the dendritic structure still in evidence.

It was because of the feelings expressed in the preceding paragraph that the writer championed, while connected with the ordnance department, a more liberal specification as applied to sulphur, though accompanied at the same time with such a method of inspection at the casting plant consisting of an examination of test bars, annealing lugs, visual examination, etc., that the real quality of the castings, or as near real as possible might be ascertained.

Malleable Foundries Raise Their Standard

THE man who has become accustomed to manufacture a product and have it accepted by his customers without inspection or question does not, as a rule, take kindly to working according to specifications. At first there is usually a little resentment and a feeling that getting defective material by the inspector when possible is all part of the game of business. But after the manufacturer becomes used to working to specifications and begins to understand fully their importance to his own interests as well as those of his customers his entire viewpoint changes and he finds himself constantly striving to improve the quality not only of his own output but that of his competitors' as well.

Specifications requiring physical tests have been applied to rolled and forged steel in different forms for many years and the manufacturers have become accustomed to presenting evidence of quality, either through certificates of test or by having samples of the material tested in the presence of an inspector. But for some reason specifications on castings have seldom been demanded in the past and even now many castings are purchased without the buyer insisting on their meeting definite physical requirements.

Steel castings are purchased on specifications more frequently than others at the present time while gray-iron castings are least often purchased with test requirements. Malleable iron occupies a middle ground. Like all other castings those made of malleable iron are subject to great variation in physical properties if not properly made. In the past this fact has worked against the use of malleable castings in many places for which they are decidedly the most fitted. Some years ago, of all the foundries producing malleable castings, none was making iron having as good physical properties as it is practicable to attain, and frequently the castings had a tensile strength of less than 40,000 pounds per square inch.

Under these conditions many consumers, especially among the railroads, were loath to call for malleable where steel castings could be used. Some of the most progressive of the malleable iron foundrymen who were making a good grade of iron realized that something should be done to improve the quality of their own metal as well as that coming from foundries whose standards were low.

This question was brought before the American Malleable Castings association which decided to take steps to improve the general quality of the iron made by all its members and to assist those foundries among its membership which were making castings with physical properties below the average. In order to accomplish these ends arrangements were made, several years ago, with Prof. Enrique Touceda, Albany, N. Y., to carry on research work, test samples from member foundries, and to visit those foundries needing metallurgical advice.

Soon after the inauguration of this work the quality of the output began to improve in all of the foundries affected and those which were turning out the lower strength iron were helped to bring their metal more near the average of the other foundries. When these results were accomplished, the association began to urge higher requirements in specifications for malleable castings in order to inspire greater confidence among the users of this material.

The members of the association are privileged to send daily samples to the laboratory of Enrique Touceda for test, and if the physical properties of the test pieces do not come up to the standard set by the association, the foundry making the particular iron is assisted to improve the quality of its metal. This system having proved successful, the association has recently taken another step to improve the quality of the malleable castings output of the country.

The new plan is to issue a certificate to each foundry which for three months has sent daily samples for test, in cases where every one of these samples has met the requirements of the association as to physical qualities. At present a minimum of 45,000 pounds per square inch tensile strength and 7.5 per cent elongation in 2 inches is demanded of foundries making railroad, motor vehicle, agricultural implement and general machinery castings.

For the quarter ended June 30, 1919, 32 members of the American Malleable Castings association out of a total of 62 have a continuous record for three months of meeting the requirements laid down. These requirements are the same as those given in the standard specifications for malleable castings of the American Society for Testing Materials.

Welding Gray Iron

By H. E. Diller

Question—We have difficulty in obtaining a soft, machinable weld on small gray-iron castings. Please inform us how to make a weld which will be soft and easily machined.

Answer—In welding small gray-iron castings care should be taken to have the entire casting heated to at least 200 degrees Cent. before starting to weld. Iron having 2.75 to 3 per cent silicon should be used for the welding rods. The casting should be cooled slowly after welding.

If you follow these instructions you should have no trouble but if you do experience any difficulty, heat the castings a little higher before welding and anneal them at 500 degrees Cent. after the welding is finished. The castings should be cooled slowly as indicated

Making Steel in the Iron Foundry

A Side Blow Converter Installed in a Gray-Iron Foundry Could Take Care of Miscellaneous Cast Steel Requirements—Low First Cost of Converter an Advantage

BY GEORGE P. FISHER

STATISTICAL reports of the American Iron and Steel institute, classifying the steel castings produced in the United States according to the process used for melting and refining, contain the following production figures in gross tons for 1916 and 1917:

	1916		1917	
	Gross Tons	Per Cent	Gross Tons	Per Cent
Open-hearth	1,176,449	85.76	1,213,156	84.16
Converter	142,791	10.41	159,272	11.05
Crucible	9,351	0.68	3,834	0.26
Electric furnace	42,870	3.12	64,911	4.50
Miscellaneous	302	0.03	234	0.02
Total	1,371,763		1,441,407	

At the date of this paper the figures for 1918 have not been published.

Each of the three principal processes for the manufacture of steel castings has advantages and disadvantages as compared with its rivals, and each has its own separate and distinct field of operation. As shown by the above figures about 84 per cent of the tonnage of steel castings is credited to the open-hearth furnace, 11 per cent to the converter, 4.5 per cent to the electric furnace and 0.5 per cent to the crucible and miscellaneous.

Any foundry proposing to manufacture steel castings must consider which process will prove most economical and satisfactory for its particular class of work. With a proper selection of raw materials and the requisite amount of care and skill, good castings can be produced by all three processes, and it is equally true that without proper care and skill very poor castings can be produced by any of the processes mentioned.

Practically all heavy castings, by which we mean those weighing from 500 pounds up, and having sections of ½ inch or more, are cast from open-hearth metal. Where large tonnages are desired and where the sections of metal permit the use of relatively cold steel, without excessive loss due to misrun castings, this process is usually the first choice. It is considered essential for economical operation that the furnace be operated continuously for 24 hours per day and when conditions permit this, open-hearth steel can be made at a lower cost than steel by any other process. An open-hearth shop requires relatively more floor space per ton of castings produced because the heats are larger and are tapped at less frequent intervals.

Steel foundries are classified roughly as those specializing on heavy work and those specializing on small light work. In the latter class we invariably find the electric furnace or the side-blow converter. These two processes practically monopolize this field because of the extremely high temperature attainable in the melted metal by either of them. With either the electric furnace or the converter no difficulty is encountered in tapping steel at from 3000 to 3200 degrees Fahr., which permits the manufacture of castings weighing as little as 2 to 3 ounces each, and having sections as light as ⅛-inch. The modern steel foundry specializing on light work accepts orders for castings which used to be considered too small and intricate for any but malleable foundries.

Electric Furnace

The arc-type electric furnace has become an important factor in the steel casting industry since 1915, during which year 23,064 gross tons of steel castings were made in electric furnaces. Furnaces of this type are able to produce metal of sufficiently high temperature to cast the lightest and most intricate castings, and can be operated with either basic or acid linings. Because of their neutral non-oxidizing atmosphere they can use very light scrap or even steel turnings. A few electric furnaces are known to be charging 100 per cent scrap and borings, and all of them are using a very high percentage of old metal, probably 85 per cent or more.

A very high degree of metallurgical skill is necessary for the successful operation of an electric furnace, and for economical results the furnace should make steel continuously for 24 hours per day. Only by continuous operation can reasonable power costs be maintained, and the cost of power is one of the most serious considerations in producing electric steel. Even when it can be obtained at as low a cost as one cent per kilowatt-hour, the power cost per ton of metal melted, with good practice, is in the neighborhood of $6.50 to $7.50. With poor practice the costs are very much higher. Electric furnace manufacturers publish figures showing that electric furnace metal can be produced at a cost about on a par with open-hearth steel and about one cent per pound lower than converter steel. These figures no doubt hold good under conditions of continuous furnace operation and cheap power rates, but not under ordinary conditions.

The side-blow converter is in operation in about 100 steel foundries in the United States. It has been used for the manufacture of small steel castings for nearly 20 years and the production of castings has increased from 14,000 tons in 1903 to 159,000 tons in 1917. Only the electric furnace can competc with the converter in producing temperatures which permit the casting of very light sections and small intricate shapes. The great advantage of the converter over all other processes lie in its great flexibility, ease of operation and small initial investment. It can be placed in operation on an hour's notice and can produce 20 heats per day or only two or three at practically the same cost per heat. Heats are blown in from 12 to 15 minutes each. When not in operation it requires no attention and the only costs against an idle converter are depreciation and interest on investment, both of which are negligible. The heats are small and produced at short intervals, permitting floor space to be used over several times during the day.

The usual charge in converter practice consists of 40 to 50 per cent of pig iron and 60 to 50 per cent of scrap. The author has seen a converter operated successfully on 100 per cent of steel scrap by adding ferrosilicon to bring the silicon content to the required figure. Because the converter must be operated with an acid lining, it is necessary to purchase raw material having a low phosphorus and sulphur content.

Many plants operating an iron foundry have a demand for steel

Paper presented by George P. Fisher at the annual convention of the American Foundrymen's association held in Philadelphia, Sept. 29-Oct. 3.

castings. Where this demand is intermittent and not for a large tonnage, the side-blow converter is an ideal installation. The melting equipment for the gray iron foundry and for the converter steel foundry is the cupola, which is already installed. When steel is required the metal can be melted in the same cupola ahead of the gray iron mixture. The converter occupies very little floor space and requires no attention when idle.

In the case under discussion we are assuming a demand for a small tonnage and in this case initial investment is worthy of serious consideration. The converter can be installed and put in operation for approximately one-sixth of the cost of an electric furnace and one-half to one-third the cost for an open-hearth furnace.

Perhaps the most important factor is the ease with which a converter can be operated. It is unnecessary to employ a high-priced furnace operator who is of little or no use when there is no demand for steel. The foundry foreman or any intelligent employe can be trained in a very few weeks to operate a converter and produce good steel. If only two or three tons of castings are required per day the time necessary to blow the steel takes perhaps an hour per day of the foreman's time, which interferes with his regular duties only to a very small extent.

Because of the speed with which steel can be produced and the high temperature of the metal it is possible to accumulate two or three blows from one converter in the same ladle to pour an occasional large casting. This is impossible by any other process for making steel and is a great advantage in a shop where it is impossible to predict what size of casting will be demanded. While large castings weighing several tons each can be made as just described from a 2-ton or even a 1-ton vessel, the converter finds its greatest application in the manufacture of small and very light-sectioned castings.

Threaten Increased Duty on Graphite

RECENTLY two bills were introduced in the house of representatives, which provide an increased duty on imported graphite and fire clay suitable for use in the manufacture of crucibles and other foundry supplies. The tariff proposed would be from one cent per pound up to six cents per pound according to the grade of the material. The apparent object of these bills is to protect the miners of domestic graphite but this legislation if passed would tend to work a serious hardship on the foundry business as well as on other industries using graphite. The Foundry Supply Manufacturers association has taken up the question in order to show what effect the passage of the bills would have upon the foundry business and indirectly upon the cost of manufacture in all lines using foundry products.

The bills as introduced read as follows:

"H. R. 5941.—A bill to provide for the national security and defense by encouraging the production and refinning of graphite (plumbago, silver lead) ores in the United States and in its possessions, and to provide revenue for the government of the United States.

"Be it enacted by the senate and house of representatives of the United States of America in congress assembled, that on and after the day following the passage of this act there shall be levied, collected, and paid upon the articles named herein, when imported from any foreign country into the United States or into any of its possessions, the rates of duties which are herein prescribed, namely:

"First.—Crude graphite ores, crystalline or amorphous, 1 cent per pound of ore for ores containing 50 per centum or under of graphite carbon, 2 cents per pound of ore for ores containing over 50 per centum of graphitic carbon, the term crude graphite ores being defined for the purposes of this act as ore which has not been subjected to any process of refining or concentration which changes the graphite content of the ore as mined.

"Second.—Lump and chip crystalline graphite (plumbago, silver lead), 3 cents per pound of graphite, the term lump and chip being defined for the purposes of this act, as larger crystals of graphite more or less broken up in mining and treatment, of a size which will not pass through a screen with openings one-quarter of an inch square.

"Third.—Flake crystalline graphite (plumbago, silver lead), crude concentrates and refined flake, 6 cents per pound of graphite, the term flake being defined for the purposes of this act as smaller crystals of graphite more or less broken up in mining and treatment, of a size which will pass through a screen with openings one-quarter of an inch square.

"Fourth.—All other products, manufactured materials, and compounds containing graphite, crystalline, or amorphous, not specifically provided for in this act, 5 cents per pound for the graphite contained therein."

"H. R. 5547. A bill to repeal paragraph 450 of an act entitled 'An act to reduce tariff duties and to provide revenue for the government, and for other purposes,' approved Oct. 3, 1913.

"Be it enacted by the senate and house of representatives of the United States of America in congress assembled, that paragraph 450 of an act entitled 'an act to reduce tariff duties and to provide revenue for the government, and for other purposes,' approved Oct. 3, 1913, be, and the same is hereby, repealed.

"Sec. 2.—That on and after the day following the passage of this act there shall be levied, collected, and paid upon all clay suitable for or used in the manufacture of graphite or other crucibles, or used in the manufacture of glass melting pots or tank blocks, when imported from any foreign country into the United States, or into any of its possessions except the Philippine islands and the islands of Guam and Tutuila, a duty of 10 dollars per ton."

As will be seen from a study of these bills the price of imported graphite and of clays for crucibles would be materially increased. Graphite, silver lead or plumbago, as it is called in the foundry industry, is used in foundry facings and for finishing molds and the imported varieties would be increased 50 per cent in cost. Graphite also enters into the manufacture of crucibles used in brass and other nonferrous metal casting shops and in the manufacture of crucible steel. The cost of such crucibles would not only tend to be increased by the cost of graphite but also by the extra cost of clays as provided by one of the proposed laws.

It is estimated that fully 80 per cent of the graphite used for foundry facings is imported. So far no graphite has been found in this country of a quality which will fully replace the foreign graphite obtained from Ceylon, Canada and Mexico, either for foundry facings or for crucibles. This was made apparent in regard to crucibles during the war when it was next to impossible to obtain crucibles which would have more than half the length of life of the crucibles made previous to the war from foreign graphite and clays. The necessity for having the proper grade of graphite for facing molds is seen when a rough, scabby casting results from the use of an inferior grade of facing.

Unfortunately graphite cannot be worked over to secure the grade desired as is the case with many grades of ore which can be made into any kind of steel according to the process used; but little can be accomplished in the way of securing a high-grade graphite from one which is inferior as it comes from the ground. This leaves little alternative but to use an inferior grade of domestic graphite or to import material of the quality desired and pay the increased price.

How and Why in Brass Founding

By Charles Vickers

Alloying Lead With Zinc

We have a large quantity of white-metal scale weights to make weighing ½, 1 and 1½ pounds each. The specifications demand an alloy of 90 per cent zinc, and 10 per cent lead. We have not been able to get the lead to mix with the zinc, although we have tried various ways. The lead always goes to the bottom of the pot. We would like, therefore, to know if this mixture can be made, and if so, how. We presume these weights are specified in zinc to have a cheap, hard metal, and the lead is specified to add weight and take up some of the shrinkage. If this mixture cannot be made we would like to have you suggest a cheap, hard mixture that could be used in its place.

Lead and zinc only alloy in limited proportions, much less than 10 per cent lead to 90 per cent zinc, therefore, while it may not be impossible to get these metals to remain together in the percentages named, it will never be done by simple melting and stirring the two metals. The two metals have no affinity for each other and the result is that the lead settles to the bottom when the molten, mixed metals are allowed to stand. We, however, would not like to go on record with the statement that these metals cannot be held together in any proportion, because the case is very similar to that of copper-lead alloys, and aluminum-lead alloys, the lead will separate from all of these metals, but in practice alloys of copper and lead are being made containing all proportions of lead. Some of these alloys resemble babbitt, but have a high melting point because high in copper. In the case of aluminum-lead, alloys of these two metals are being made containing up to 10 per cent lead. To make these mixtures is a trick in alloying, known to those who have studied the matter and have done the necessary research work. Naturally, information on the subject is difficult to get, as the secret is guarded by those who possess it. Alloys of lead and zinc possess no commercial importance, therefore, few have done any experimental work to learn how to hold the metals together when solid. It could no doubt be done by the addition of some third metal that had affinity enough for both lead and zinc to hold them together. In this connection, possibly magnesium would be worth a trial. We believe that as a very cheap alloy is demanded the addition of a third metal would make the alloy too costly, and that the better way would be to make an alloy of zinc 98.50 per cent, lead 1.50 per cent, and to enlarge the patterns to compensate for the lower specific gravity of this alloy, as compared with the alloy specified.

The weights could also be cast in the ordinary leaded zinc used for making common brass, and brought up to weight by pouring lead into cavities made for the purpose.

Formulas for Muntz Metal

Can you advise us regarding the composition of Muntz metal, or where same can be purchased?

Muntz metal is a yellow brass first used extensively as a sheet metal for sheathing ships. It was patented in England in 1832 and was named after the inventor. The first specifications were copper 60 per cent; zinc 40 per cent. A third patent in 1846 specified, copper 56 per cent; zinc 40.75 per cent, and lead, 3.75 per cent.

At the present some makers claim the zinc should not be higher than 38 per cent. The following are analyses of two alloys:

	Per cent	Per cent
Copper	60.52	59.52
Zinc	38.80	39.43
Lead	0.40	0.74
Nickel	none	0.39

For casting purposes use copper, 58.50 per cent; zinc, 40.00 per cent; tin, 0.50 per cent, and 10 per cent aluminum bronze, 1 per cent.

Muntz metal can be purchased from any concern specializing in ingot metals.

Bronze Propeller Mixture

We would like to have a good mixture for a bronze propeller.

The mixture will vary depending on the diameter of the propeller desired.

The best alloy to use for propellers is manganese bronze, but it must be of the highest grade and not simply a yellow brass with a little aluminum added. For a small propeller a good grade of red brass can be used, and suitable alloy is the following: Copper, 88.50 per cent; tin, 6.50 per cent; zinc, 3.50 per cent, and lead, 1.50 per cent.

Alloy for Match Plates

Can you advise as to a satisfactory material for making patterns for match plates?

For making patterns for match plates a white metal is very satisfactory. Such an alloy can be made of zinc, 50 per cent and tin, 50 per cent. Melt the zinc first, then add the tin gradually. Before adding the tin however it is advisable to add a piece of sheet aluminum 2 inches long and 1 inch wide, the thickness of ordinary cardboard. This alloy is suitable as it possesses so little shrinkage that rapping of the master patterns before drawing them out of the sand usually makes up for the shrinkage.

For the pattern plates themselves, use aluminum alloy of the composition, aluminum, 92 per cent; copper, 8 per cent.

Sometimes the match and patterns are cast solid of plaster of paris, in which case a drag is rammed up and the joint finished carefully, then an interchangeable cope is placed over the drag, and is filled with plaster. When set, the patterns are trimmed and shellacked. Two blocks are required, one for the cope and another for the drag.

Formula for Roll-Neck Bearings

We would like to obtain the formula for a bronze for roll-neck bearings, to be cast in iron molds. These bearings are not for heavy duty rolling. The largest rolls are approximately 12 x 36 inches.

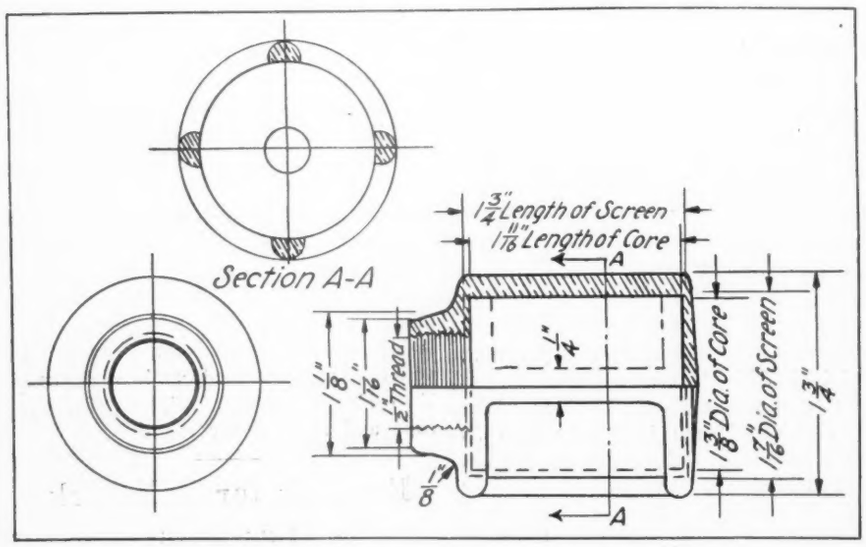
The following formula will give a bronze that will be suitable for the purpose outlined: Copper, 86.50 per cent; tin, 8 per cent; lead, 5 per cent, and phosphor copper, 0.5 per cent. The phosphor copper should contain 15 per cent of phosphorus. If the alloy fails to run as well as desired, the phosphorus can be increased, deducting the increase of phosphor copper from the copper content of the alloy.

Prepare the chills by warming them and then painting with a mixture of lard oil and plumbago, thin enough to flow from the brush. Apply a layer of French chalk over the oil and plumbago with a smooth camel-hair brush. Have a heavy riser in a dry sand head.

Casting Defects Remedied by Changing Gate

We have experienced considerable difficulty in getting good castings for the pipe strainers shown in the illustration. The castings consist of a brass cage ***with solid bottom and a circular,*** *threaded top, and the sides of the cage are formed of brass screen held in place by the ribs on the casting which join its bottom and top. The screen is cast in place being wrapped around the core, which shapes the inside of the cage. The difficulty consists of cold shuts and misruns. The percentage of loss is high.*

We use scrap yellow brass with possibly some valves thrown in, which is melted in an oil-fired furnace. We ***add several ounces of aluminum to*** *aid in running the metal but there is no phosphorus present. The machining qualities have been good until recently when only 10 castings could be threaded per tap. One lot analyzed as follows: Copper, 76 per cent; zinc, 22.10 per cent; iron, 0.60 per cent; lead, 1.20 per cent; tin, trace. Can you suggest a cheap mixture or something to add to the mixture to give it fluidity and thus overcome misruns and coldshuts? Please explain the effect of common salt on the melting of brass, also the effect and the advantage of using boron, and what effect lead has on the machining quality of brass in different percentages Does a brass with as high a lead content as 20 or 30 per cent resist machining by becoming gummy?*



PLAN AND SECTIONAL VIEWS OF PIPE STRAINER CASTINGS

It is assumed these strainers are cast horizontally with the parting line of the mold passing through the centers of two opposite ribs, which leaves one rib at the highest point of the cope. If the strainers are made this way the rib at the highest point will be the one to misrun most often. If the castings are placed lengthwise of the flask and the mold is tilted, a gate at one end and entering the side of the casting will run them. But if the gate is cut so as to form an acute angle with the runner so the metal can shoot into the strainer, the castings at the top of the mold which are nearest to the sprues, will be misrun in the majority of cases. This is due to the fact that the metal does not fill the strainer when it shoots in but passes on down the runner and leaves a little metal in the upper strainer molds, which of course immediately sets. If the gates are so adjusted on the plates it would be better to pour the molds on the level with the sprue at one end. In pouring the molds on the level it is better to locate the sprue in the center of the mold, provided the branch gates to the castings are set for center pouring, and allow the metal to shoot into the castings in both directions from the center of the runner. If the molds are to be tilted with the sprue at the highest end the two lower castings may be gated so the metal shoots into the strainers, although this is a debatable point. The gates leading to the castings higher up along the runner must be so cut that the metal will shoot past them and strike the bottom of the runner first, then as it floods back it will fill all the upper strainers uniformly and there will be few coldshuts. It is difficult to decide without a test just what is the best way to run these castings; whether on the level or on an incline, but if they are poured on the level we believe it would be the best to center gate them; that is pour from the center of the mold. In the latter case it would be well to increase the height of the pouring head if possible to do so without adding to the molding costs. If this is not possible the metal will have to be poured rather hot and poured very decisively.

We would also suggest a trial of the following alloy for these castings: copper, 56.50 per cent; zinc, 40 per cent; lead, 3 per cent; aluminum, 0.50 per cent. If the alloy does not cut with sufficient ease, the lead can be increased to 5 per cent at the expense of the copper. Then if the metal appears too brittle the zinc should be lowered a little. Also before weighing the flasks, take a gate cutter and cut a channel in the sand of the cope over each row of castings. This lets the gas off and greatly aids in running the castings. The reason the alloy the analysis of which is given, is difficult to machine is due to the iron content. The high percentage of iron is obtained from the scrap. This is one great objection to the use of scrap for such castings, for by increasing machining costs a mixture using scrap often makes the castings more costly than if they had been made entirely of new metal.

Salt protects brass when melted with it because the salt volatilizes and fills the crucible and a part of the furnace with fumes. These fumes are so persistent that once salt is added in quantity it can be detected for several melts, even if no more is added.

Boron has no effect on brass because like carbon it is insoluble in copper and its alloys. Its salts such as borax and boric acid makes good fluxes as they dissolve oxides, but should not be used in quantity as then they would carry away copper. Metals that absorb and retain carbon, absorb and retain boron, thus aluminum and iron take up boron, and so does nickel, but if boron aluminum that is brittle with boron is added to copper the boron is lost by being thrown out and oxidized immediately and absolutely no effect is obtained by adding the boron. The effect is exactly the same as when cast iron and copper are melted together; the two will not mix because the iron has a greater affinity for its carbon than it has for copper but if aluminum is added the copper and the iron unite and the carbon held by the iron is released and bobs to the surface of the melt as a flocculent dross. The aluminum acts as a cement because it combines eagerly with both copper and iron. The effect of lead is to improve the machining qualities of brass in all proportions. Alloys containing as much as 66 per cent of lead are white in color and machine perfectly.

Getting Ready for Huge Production

Details of Plant Built Expressly to Handle a Large Tonnage of Motor Castings Expeditiously — Forced and Induced Draft Used in Drying the Cores — Castings Poured Continuously

BY PAT DWYER

IF Pere Marquette, the black-robed Jesuit, could have looked into the future while engaged in that perilous search for the sources of the Mississippi, he would have felt both gratified and disappointed. His explorations in the country now called Michigan were carried on under the impetus of the society's motto, "for the greater glory of God," and his own patriotic desire to acquire new territory and thus add to the power and prestige of France. He would have been gratified to know that the land which he claimed in the name of his Louis XIV was destined to become great, rich and prosperous from the exploitation of her apparently inexhaustible lumber and mineral resources, but he would have felt disappointed because she was destined to pass so soon and forever from under the aegis of the Fleur-de-lis.

The immense forests, which forced Marquette to do all his traveling by birch-bark canoe, laid the foundation in the lower peninsula for the growth of Detroit, Saginaw and Bay City. Millions of feet of white pine floated down the rivers and were squared into lumber.

The picturesque rivermen, with their little cocked hats, peavies and spiked shoes are becoming a thing of the past and the lumber industry although still important, is no longer in the limelight. The manufacture of motors and motor-cars is now the premier industry of Michigan. Immense plants have been erected in various parts of the state for this purpose and in spite of their tremendous output they cannot keep pace with the demand. Large foundries are operated in connection with nearly all of these plants.

One of the finest and most modern of these foundries has been built recently in Saginaw, Mich, at a cost of $3,000,000, for the Saginaw Product's Co., a subsidiary of the General Motor's Corp. This foundry was designed by Frank D. Chase, Inc., industrial engineers, Chicago, and built under their supervision. The property assigned for foundry development is served by several spurs from the Pere Marquette railroad and covers 65 acres. The present plant covers approximately one-third of this area and it is the intention of the company eventually to erect two other similar units, thus utilizing the entire property. The first unit now completed, is expected to furnish employment for 900 men who will turn out 200 tons of cleaned castings daily. Many of the appliances and special features about the plant were installed at the suggestion of J. J. Wilson, general foundry superintendent for the General Motor's Corp., who drew on his unusually wide experience in the production of automobile castings.

The group of buildings comprising the first unit consists of a foundry building, 165 x 450 feet; a cupola room, 40 x 163 feet; a coreroom, 101 x 390 feet; a cleaning room, 110 feet 6 inches by 281 feet 9 inches; a 2-story pattern building, 158 feet 10 inches by 100 feet; and a washroom, dining room and office building, 261 feet 6 inches by 80 feet 3 inches. The powerhouse is situated 100 feet west of the cleaning room. One of its outstanding features is a radial brick stack 225 feet high by 9 feet in diameter at the top. This building takes the shape of an L 86 feet 6 inches by 93 feet 9 inches.

The walls of the buildings are of brick and steel construction while the roofs are built of gypsum tile. This material is a non-conductor and prevents condensation. An A-frame on the roofs of the coreroom and cleaning room and a modified Pond truss on the foundry building, together with an almost con-

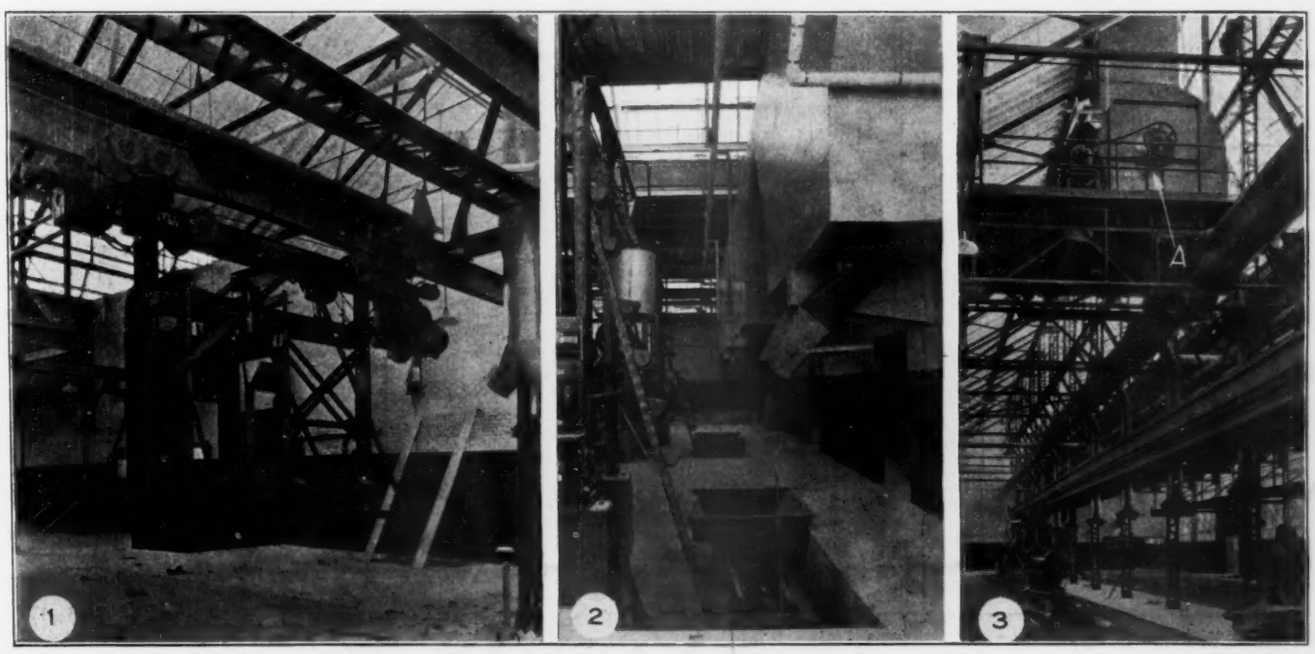


FIG. 1—ELECTRIC MONORAIL HOIST FOR HANDLING THE IRON FIG. 2—CORE-SAND HOPPERS AND CONVEYORS FOR THE MIXING MACHINES. FIG. 3—ONE OF THE BLOWERS AND SYSTEM OF PIPING FOR SUPPLYING THE SHOP WITH HOT AIR

tinuous sash in the walls insures ample light on the floors. In addition, the buildings are all painted a light yellow on the inside which renders the lighting conditions ideal. The sash in both walls and roof are movable and are operated electrically. This simplifies the ventilation problem to a considerable extent.

A group of three 600-horsepower Edgemoor boilers supplies steam for heating the buildings and also for operating three direct steam-driven Ingersoll-Rand air compressors, two being 1500 and one 1200 cubic feet capacity. Coal is used for fuel. It is taken from the cars and passed through a crusher, after which it is lifted into a hopper by a bucket conveyor. From the hopper it is fed to the boiler-room by gravity through a chute.

Electric power, which is purchased from outside interests, is supplied at 2200 volts, 3-phase, 60 cycles. The connected load totals 1400 horsepower, the lighting load being 150 kilowatts. Three transformers step down the voltage to 440 volts for the power load while a smaller set handles the lighting load. By means of a motor-generator set, direct current is supplied for operating the cranes. The generator sets, which are duplicated to cope with emergencies, are housed in a room in the northeast corner of the foundry building.

Since cores enter so largely into the production of automobile castings it is only natural that the coreroom of this plant should occupy nearly as much space as the foundry. It is the same length as the foundry and only 53 feet less in width. The 32 core ovens were built by Holcroft & Co., Detroit. They are arranged back to back with eight in a row making two batteries of 16 each. Each oven is 12 by 6 feet 6 inches by 7 feet. A continuous flue runs under each row of eight ovens, terminating in an individual stack. There are two openings in the floor of each oven connected with the flue. They are provided with dampers controlled by chains which hang down outside the door. Two outlets are provided in the side walls for the gas and steam, one opening near the top and the other below the floor level. These openings are provided with slides operated from the outside. With these dampers it is possible to control the temperature in the oven quite closely. A pyrometer is attached to each oven in order to keep a record of the heat fluctuations.

The fire boxes for the ovens are in the basement. A long concrete incline leads from the coke storage outside the building down to the basement floor and coke is taken down for the fires and the ashes removed in wheelbarrows. The firing pit, flues, and draft facilities are so perfect that it does not require any more coke to fire a battery of eight ovens than it does in some foundries for a single one. Both forced and induced draft are employed. The firing room in the basement is furnished with air-tight folding doors. Whenever it is necessary to increase the draft these doors are closed and the air pressure raised by a fan, on the same principle as that in use in the fireroom of a battleship.

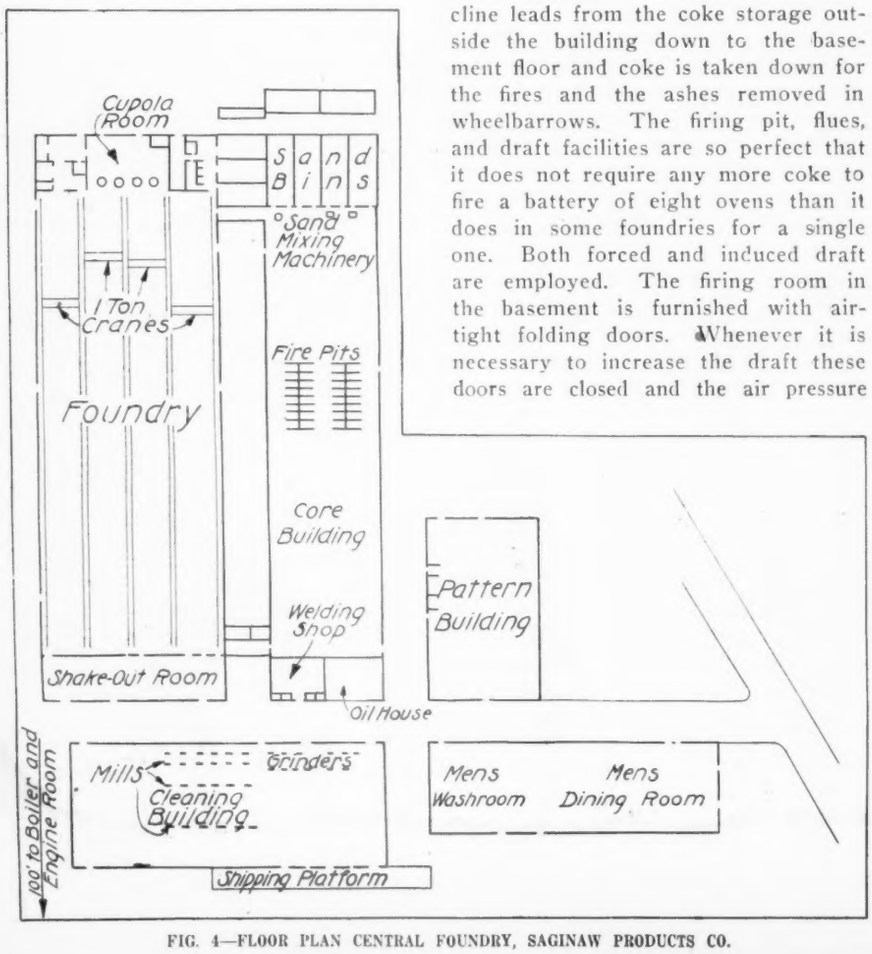


FIG. 4—FLOOR PLAN CENTRAL FOUNDRY, SAGINAW PRODUCTS CO.

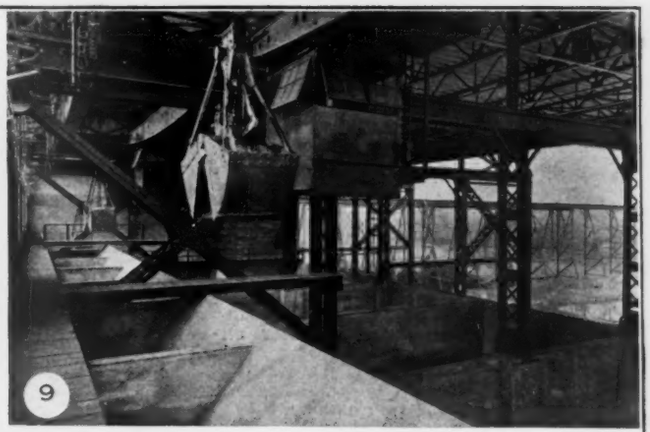
The stack for each battery of ovens is situated at the opposite end from the fire box. They are clearly shown in Fig. 5. This illustration also shows a fan driven by a 15-horsepower motor, connected to both stacks and used to furnish the induced draft necessary. The cores are loaded on racks and taken in and out of the ovens on electrically operated trucks.

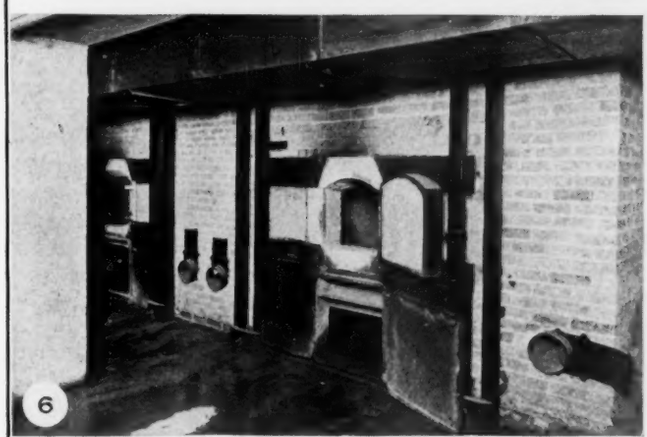
The ovens are situated midway from both ends of the building. Their general appearance and relative size in comparison to size of the building are shown in Fig. 8. Provision has been made for doubling the number of ovens if necessary. The basement extends under the space required for additional batteries, a temporary brick wall shutting off the space used at present in order to render it air tight when the forced draft is in use.

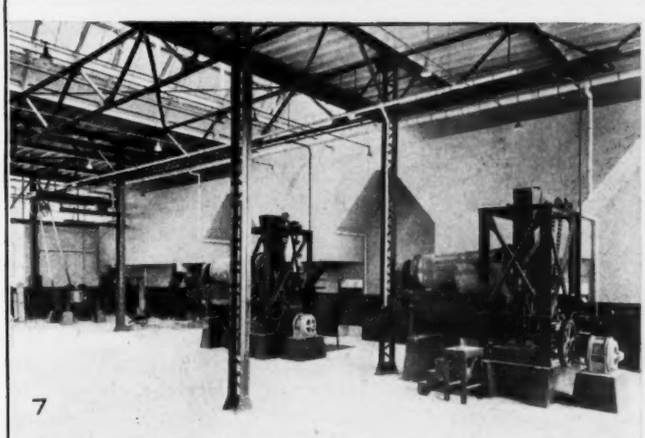
Among the many kinks to be found around this plant may be mentioned the cams shown on the posts beside the oven doors. When these cams are thrown up the door has plenty of latitude in the guides and will not jam when being pulled up or down; when the handles of the cams are pulled down they force the door tightly against the guides thus preventing any of the heat from escaping.

Core-oil is stored in a large tank below the ground level, immediately outside the south wall of the coreroom and in line with the core ovens.

The core sand is stored in four concrete bins each 25 x 63 feet having a total capacity of 8000 tons. They are roofed over and the sand transferred to them from the railroad cars by means of grab buckets having a capacity of 1¼ cubic yards each. Each pair of bins is served by a 5-ton Pawling & Harnischfeger crane. Adjacent to the bins and opening into the coreroom are three double hoppers, that is each hopper has a dividing wall in the center. These hoppers, which are loaded from the sand bins on the outside by the cranes, discharge on the inside of the building into a battery of mixing machines. Front and side views of the hoppers and machines are shown in Figs. 2 and 7. There are two revolving screens and mixers built by the Standard Sand & Machine Co., Cleveland, and one No. 2 Simpson pan mixer built by the National Engineering Co., Chicago. The Standard machines are equipped with worm conveyors and bucket elevators for lifting the sand from hoppers in the floor to the screens. Each mixing







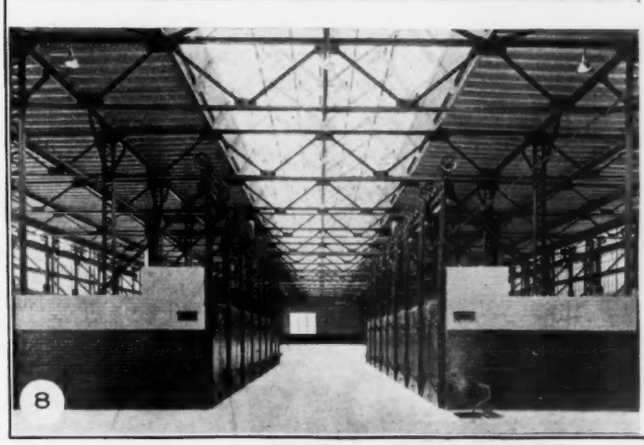


FIG. 5—ONE OF THE BATTERIES OF CORE OVENS, SHOWING THE UPPER FLUES, THE STACKS AND THE FAN FOR SUPPLYING INDUCED DRAFT FIG. 6—FIRING ROOM FOR OVENS FIG. 7—CORE SAND HOPPERS AND MIXING MACHINERY FIG. 8—TWO BATTERIES OF OVENS ARE PROVIDED FIG. 9—CORE SAND BINS AND HOPPERS FIG. 10—COURT BETWEEN COREROOM AND FOUNDRY FIG. 11—FOUNDRY INTERIOR LOOKING TOWARD THE CUPOLAS FIG. 12—FACING SAND MIXERS

unit is driven by an individual motor.

The coreroom and foundry buildings, which are parallel, are separated by a court, as shown in Fig. 10. This court is 40 x 360 feet and is paved with concrete. It facilitates the lighting of the two buildings which face each other. The two buildings are connected at both ends, at the east end by a structure housing a series of bins for holding molding sand and at the west end by a building in which dust arrester exhausters are installed.

Arrangement of Foundry

The foundry building, which is divided into four bays, has a total length of 490 feet 4½ inches and a total width of 164 feet 4 inches. Included in this however, is a space 60 feet wide at one end containing the motor-generator sets for the cranes, as well as the elevator, the cupolas, the charging floors, and the installation for mixing facing sand. At the other end there is a room 40 feet by 125 feet 4 inches where the castings receive a preliminary cleaning.

The foundry has a modified Pond truss roof and like the coreroom has adequate lighting, heating and ventilating facilities. The floors are composed of wood blocks and the gangways are paved with asphalt blocks.

The molding room is divided into four bays by the three rows of columns. The floors are further subdivided by a series of gangways which, like the molding floors, extend the whole length of the shop. Each molding floor is 24 by 380 feet; the center aisle or gangway is 23 feet wide, the pouring aisles, which come under the monorail, are 9 feet each, and the outside aisles next to the walls are each 12 feet 7 inches in width.

At *A* Fig. 3 is shown one of the installations for heating the building by the indirect hot-air system. Two No. 8 American sirocco blowers are provided. Each blower is driven by a 10-horsepower General Electric motor. The fan units are located near the center of the foundry which permits of a most economical and satisfactory arrangement of hot air ducts. Each unit is capable of delivering 28,000 cubic feet of free air per minute. In addition to this indirect system, the building is heated directly by steam which is supplied to a series of radiators occupying the space between the windows and the floor all around the outside walls.

Water, air and electric current are available at every other column. A 4-inch pipe line is laid the full length of the shop under the center of each floor; it is provided with 2-inch connections at 8-foot intervals which simplifies the setting up of a molding machine anywhere. Foundations for the permanent jarring machines are provided at each end of the shop. The continuous pouring system is to be employed and therefore each set of machines will be used alternately. The same idea will be carried out with the portable machines; they will travel down one side of the shop and up the other.

The castings will be shaken out and conveyed to the cleaning room on electric trucks. Bubbling fountains supplied with artificially cooled water are set up at convenient intervals, also several urinals are provided near the middle of the shop. Several 1-ton cranes with air hoists and one 3-ton Pawling & Harnischfeger crane spanning the center bays, comprise the lifting equipment. Most of the work is light and these cranes will be used principally for handling molds and pouring. A complete monorail installation will be used to distribute the iron to each bay. Four 2-ton hoists built by the Sprague Electric Crane & Hoist Co., New York, and similar to the one illustrated in Fig. 1, are employed for this purpose. In this style of hoist the operator not only drives the crane, he also tilts the ladle and fills the small ladles which are used for pouring the castings.

There are three molding sand bins, each 25 x 40 feet. The facing sand is mixed in a room situated between these bins and the cupola room. The mixing machinery, which is shown in Figs. 12 and 13, is in duplicate. Both the revolving screens have false bottoms controlled by levers. The correct amount of old and new sand and seacoal is measured out on the floor for one batch of facing and then shoveled into the screen. When it has all passed through, the lever *E* is reversed and the sand falls into a pocket from which it is carried to the upper floor by the aid of a screw conveyor and bucket elevator. Here it falls into a No. 2 Simpson pan mixer, from which it is carried by another bucket elevator to a centrifugal mixer built by William Sellers & Co., Philadelphia. It is then considered finished and drops down a chute through a hole in the floor back to a bin on the ground floor. A storage bin, 20 x 40 feet, is provided near the mixer for holding seacoal.

The four Whiting cupolas provided for melting the metal are shown in Figs. 17 and 18. Three of them are alike, with 90-inch shells lined to 65 inches at the bosh and 52 inches at the tuyeres. The fourth is 56 inches in diameter lined down to 40 inches. Each cupola is provided with two sets of tuyeres. the lower set being continuous. The charging platform is 24 feet above the ground and the spark arrester with which each cupola is crowned is 67 feet above the foundation. The concrete foundations for these furnaces are 11 feet square and 6 feet deep. It is calculated that when fully charged each cupola weighs 130 tons.

The blast is furnished the cupolas by three No. 6½ positive pressure blowers built by P. H. & F. M. Roots, Connersville. Each blower is driven by an individual 75-horsepower General Electric motor. They run at 175 revolutions and deliver 8300 cubic feet of free air per minute. The three blowers discharge into a common 36-inch header. From the header, 26-inch pipes lead to each of the large furnaces and a 10-inch pipe to the small one. Blast gates are provided between each furnace on the header and again immediately before each pipe enters the windbox. Each gate is operated by a rack and pinion.

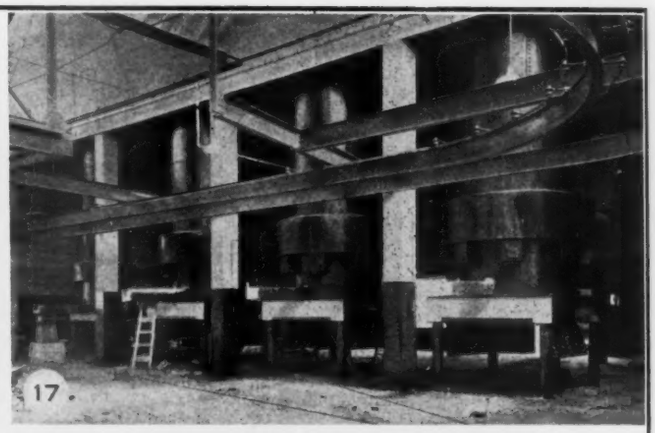
A narrow-gage industrial track with a spur running under each furnace is used for hauling away the slag and cinder from the cupola drop. Back of the cupolas, but under the same roof, is a bin for holding the clay used in daubing the furnaces and ladles, and in an opposite corner there is an oven for drying the ladles.

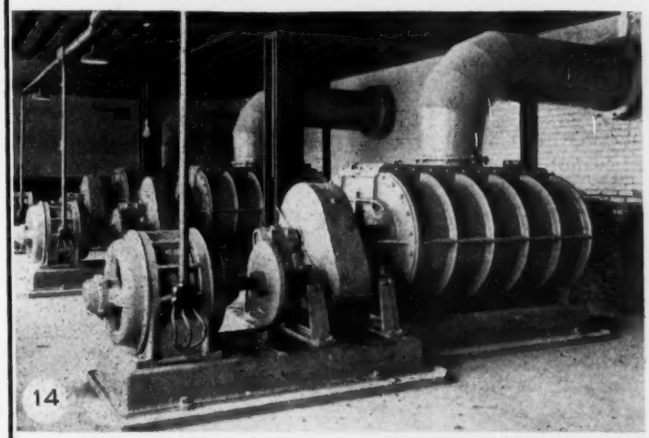
The main charging floor is shown in Fig. 15. It is provided with two Howe platform-scales and a number of bins for keeping the different kinds of iron entering into the charges separate. There is no back wall to the charging platform. A 10-ton Pawling & Harnischfeger crane with a 70-foot span hoists the charges from the stockyard shown in Fig. 16 to the charging platform, using a 62-inch magnet. This crane is also used for unloading cars and piling iron in the yard.

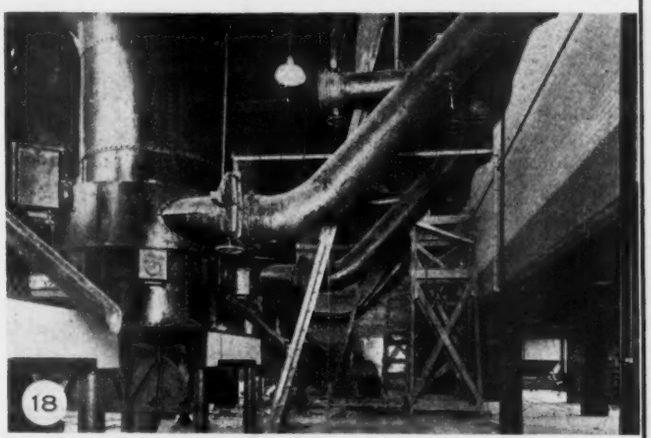
Another Charging Floor

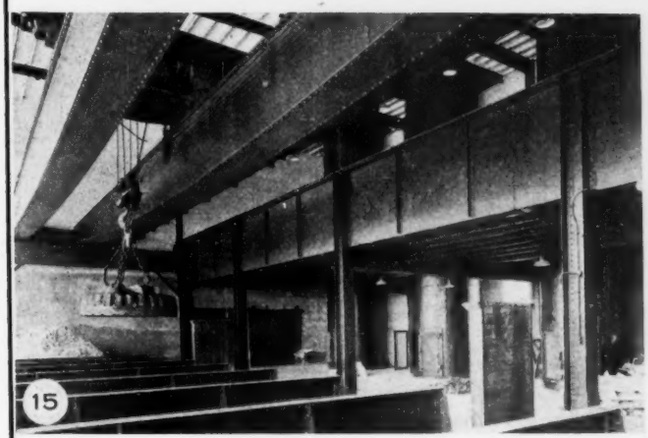
A second charging floor has been built 12 feet above the first expressly for charging sprues and domestic scrap. All the sprues, gates, etc., are brought down the north gangway by electric trucks, weighed on a Howe platform scale and taken on an elevator to the third floor. The elevator is also available for carrying charges to the main floor if anything should happen to the yard crane.

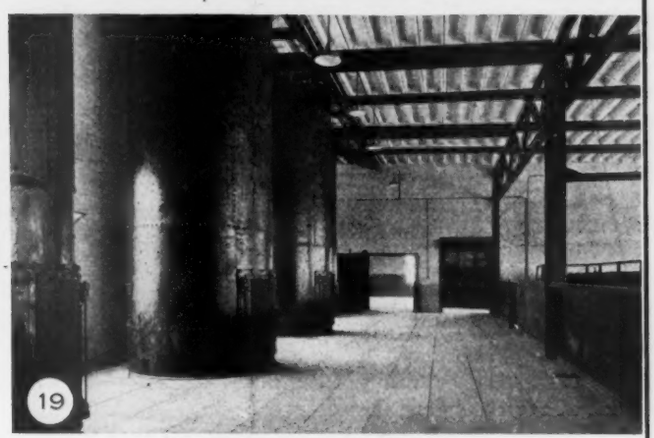
The floors of both charging platforms are made of steel plates attached with countersunk rivets to heavy I-beams and are capable of

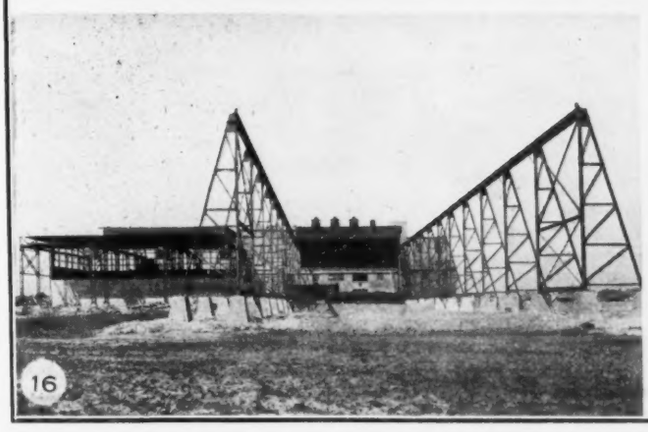












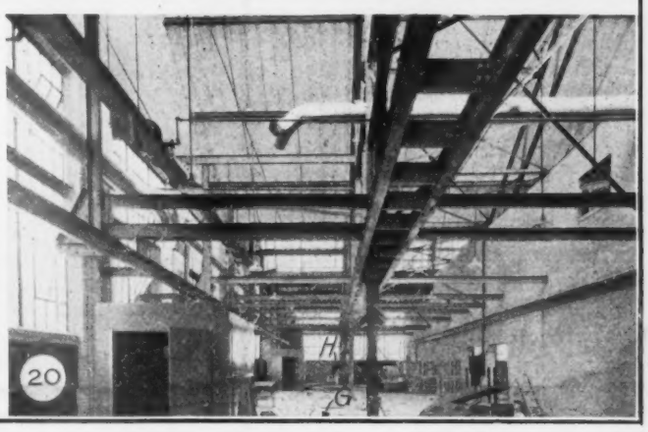


FIG. 13—UPPER FLOOR SET OF FACING-SAND MIXERS FIG. 14—CUPOLA BLOWER ROOM FIG. 15—STOCK BINS ON CHARGING FLOOR FIG. 16—CRANE RUNWAY OVER STOCK YARD FIG. 17—FRONT OF CUPOLAS FIG. 18—ARRANGEMENT OF BLAST PIPING AND CONTROL GATES FIG. 19—UPPER CHARGING FLOOR FIG. 20—PRELIMINARY CLEANING ROOM

supporting 2000 pounds per square foot. Adjacent to the charging floor a coke-storage room with a capacity of 1000 tons has been provided. The coke is discharged from the railroad cars on the outside of the building. A steel hopper provided with folding wings, which can be laid flat against the wall when not in use, guides the coke into the boot of an elevator, in which it is lifted and discharged on the floor of the storage room. This floor is on the same level with and connected to the charging platform.

A Preliminary Cleaning

The preliminary cleaning room shown in Fig. 20 is under the same roof but at the opposite end of the building from the cupolas. It is 164 feet 4 inches by 40 feet. The large cored castings, cylinders, etc., are cleaned in this room, using two sand-blast units supplied by the W. W. Sly Co., Cleveland. The cores are knocked out and the sand shoveled into hoppers in the floor, one of which is indicated at *G*, Fig. 20. A 30-inch belt driven by a 10-horsepower motor runs under the line of hoppers and carries the waste sand out through the hole in the north wall shown at *H*, Fig. 20, and delivers it into cars on an industrial track. These in turn are hauled to the dump where the sand is disposed of.

An illustration of the main cleaning room is shown in Fig. 21. It measures 281 feet 9 inches by 110 feet 6 inches. A perfectly smooth concrete floor facilitates the work of the electric trucks used for carrying the castings from one point to another. The mechanical cleaning equipment consists of one sand-blast unit supplied by the W. W. Sly Co., Cleveland, a large battery of 36 tumbling barrels built by the W. W. Sly Mfg. Co., Cleveland, and a battery of 12 double-wheel grinders made by the Norton Co., Worcester, Mass. The tumbling barrels are grouped back to back in batteries of 12; each group of six is belted to a common line shaft and driven by a 30-horsepower General Electric motor. The grinding wheels are shown in Fig. 23. The installation consists of 12 double-wheel stands carrying 4 x 24-inch wheels. They are driven from countershafts in groups of three and four by 15 and 20-horsepower motors. There is also a 4-foot surface grinder used principally for trueing the joints of the flasks used in the foundry.

The tumbling barrels and grinding wheels are attached to an elaborate dust-collecting apparatus. Individual pipes leading from each machine terminate in two large mains 36 and 42 inches in diameter respectively. These mains in turn find their outlet in one twin and two single dust arresters, each 40 feet in length and served by two Garden City double exhausters. Each of the exhaust fans is driven by an individual 100-horsepower motors made by the General Electric Co. Industrial tracks lead under the discharge pipes of the dust arrester and cars are supplied for hauling the refuse away.

The cleaning room is provided with the necessary apparatus for inspecting and testing the castings before they reach the shipping platform which is alongside the west wall of the cleaning room. The shipping department is served by a spur from the Pere Marquette railroad. Two scales are provided for checking the weight of the castings; one is a National counting scale and the other a Howe platform scale.

A supply of fuel oil is kept just west of the shipping platform in underground tanks of 10,000 gallons capacity each.

The pattern shop is a 2-story building 158 feet 10 inches by 100 feet. The lower floor is equipped with the necessary machinery for making and repairing patterns and the upper story is fitted up for a pattern storage.

The well being and comfort of the employes has been carefully considered and provided for. A building 280 feet by 80 feet 3 inches has been erected and equipped with an elaborate heating, toilet, bath and locker systems in one end; the remainder of this building is occupied by the cafeteria and foundry office.

Pittsburgh Foundrymen Start Meetings

Regular monthly meetings of the Pittsburgh Foundrymen's association for the 1919-20 season were inaugurated Sept. 15, at the Chatham hotel, with a paper by Enrique Touceda, consulting engineer, Albany, N. Y., whose subject was: "Some Pertinent Facts in Connection With Both Gray Iron and Malleable Castings." Mr. Touceda traced in interesting fashion the geology of iron, its early smelting and finally treated castings from a technical standpoint, the latter part of the talk being illustrated by lantern slides. A. M. Fulton, vice president of the Fort Pitt Malleable Iron Co., elected president of the association at its June meeting, presided, and announced the committees for the current year:

Officers and committees of the association follow: President, A. M. Fulton, Fort Pitt Malleable Iron Co.; vice president, A. J. Hartman, United Engineering & Foundry Co.; treasurer, William J. Brant; secretary, Bayard Phillips, Phillips & McLaren Co.

Executive committee: C. S. Kogh, Fort Pitt Steel Casting Co.; Henry Spilker, Sterritt-Thomas Foundry Co.; J. S. McCormick, J. S. McCormick Co.; J. Lloyd Uhler, Union Steel Casting Co.; C. F. Williams, Allen S. Davidson Co.

Program committee: G. F. Tegan, *The Iron Trade Review*, chairman; H. M. Meixner, Pittsburgh Piping & Equipment Co.; J. W. Guay, Fort Pitt Steel Casting Co.; T. J. O'Brien, Fort Pitt Malleable Iron Co.

Entertainment committee: O. C. Dobson, Corborundum Co., chairman; C. W. Forcier, Mackintosh, Hemphhill & Co.; G. A. Bauman, Jones & Laughlin Steel Co.; C. L. Kirk, Kirk Supply Co.; L. W. Mesta, Mesta Machine Co.

Membership committee: L. A. Way, Lewis Foundry & Machine Co., chairman; John B. Coates, Pittsburgh Malleable Iron Co.; John Kahl, United Engineering & Foundry Co.; F. H. Clay, Allegheny Steel Co.; R. F. Eissler, Chicago Pneumatic Tool Co.; Thomas E. Reynolds, McConway & Torley Co.; Thomas Wilson, Rogers, Brown & Co.

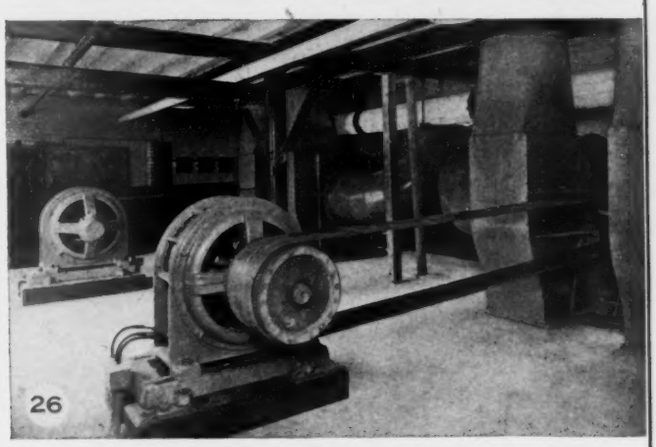
Chinese Tungsten Mines

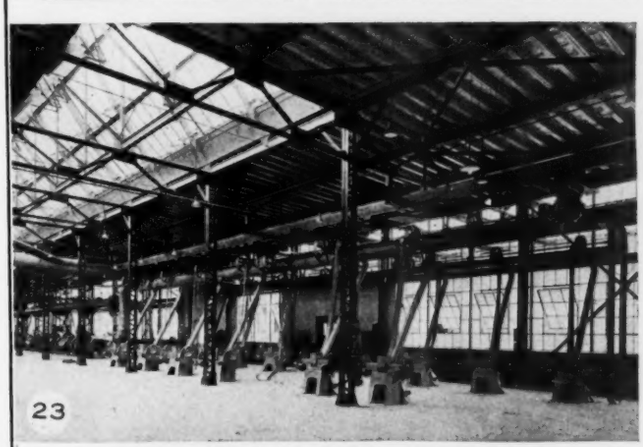
The American consul at Canton, China, in a recent report, describes a rapidly developing exportation of wolframite ore from several parts of China. When the trade in this ore began its value was not suspected by the natives, who sold it as iron ore to the Japanese at about 17 cents a pound. Now the average ore commands $32, gold, per 100 pounds at Canton. Much of it comes from Chengchow, Hunan province, and is carried on human shoulders a distance of 60 miles; then by junks 80 miles to Shiuchow; and the rest of the way to Canton by rail. Wolfram ore is said to occur at many places in Kwangtung province and also at places in Kwangsi province.

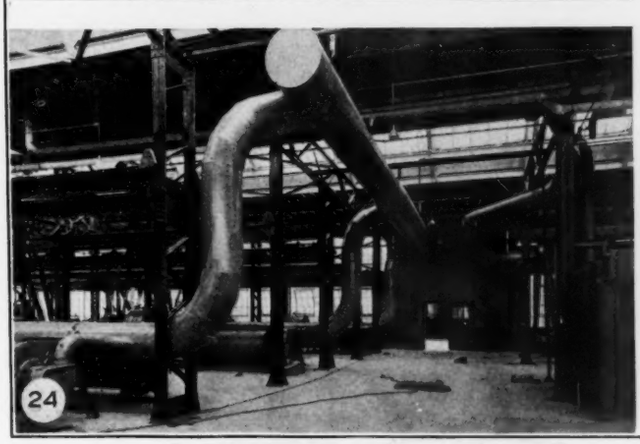
Instructions on Hoists

At a recent meeting of the Electric Hoist Manufacturers' association the engineering committee announced the preparation of a booklet entitled, "Facts for Operators of Electric Hoists." This publication is available through the secretary, W. C. Briggs, 30 Church street, New York.

The Wolff Mfg. Co. has acquired the business of the L. Wolff Mfg. Co. maker of plumbers supplies, and will extend its manufacturing facilities.







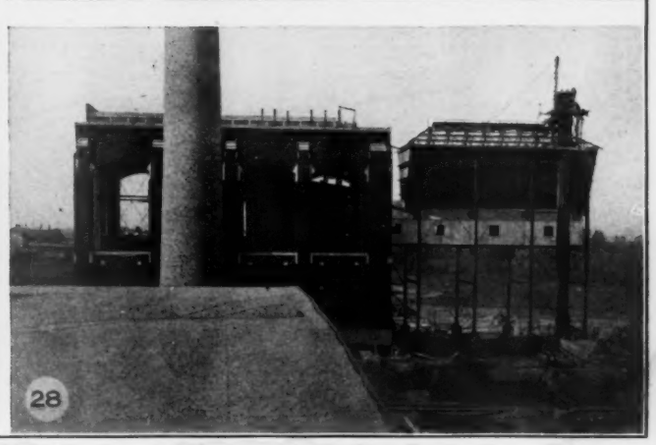


FIG. 21—GENERAL VIEW OF MAIN CLEANING ROOM FIG. 22—NOTE THE DIRECT OVERHEAD LIGHT ON THE TUMBLING BARRELS FIG. 23—THE GRINDING WHEELS ARE DRIVEN IN GROUPS OF THREE AND FOUR FIG. 24—MAIN PIPES FOR DUST ARRESTER FIG. 25—MAINS LEADING FROM THE CLEANING ROOM TO THE EXHAUSTERS FIG. 26—MOTORS AND FANS FOR DUST ARRESTERS FIG. 27—DEPRESSED TRACK AND CORE-SAND BINS FIG. 28—BOILER HOUSE AND COAL HOPPER

Bureau of Mines Laboratory Opened

Formal Dedication of the New Pittsburgh Experiment Station is Accompanied by Ceremonies Which Mark the Advance in Safety and Accident Prevention Work in Mining

MECHANICAL and mining engineers and those prominently interested in obtaining greater efficiency in the production and consumption of coal, took part in the dedication of the new million dollar laboratories of the United States bureau of mines in Pittsburgh, Sept. 29, 30 and Oct. 1. This laboratory represents the realization of a vision, the crystallization into stone and steel of the great concept of a great man who died before his work was done.

When the technical branch of the United States geological survey was organized in 1907 with Dr. Joseph Austin Holmes in charge the United States had the reputation of being not only the most prodigal nation in the expenditure of national resources, but of the lives of its citizens as well. Its leading place in the production of all the mineral substances was accompanied by a loss of life and health that resembled a vast war with the forces of nature. In 1907 there was an unusual number of mine explosions and the result was a general movement to prevent the needless loss of life. This movement culminated in the creation of the bureau of mines, for the purpose of promoting health, safety and efficiency in the mining industry.

Starting the work at Pittsburgh was a happy beginning, placing it in the center of so important a mining and metallurgical region. The bureau was housed at first in temporary and unsuitable quarters, but Dr. Holmes always kept in view a vision of a great experiment station for mining, where all kinds of accidents could be studied and methods developed for their prevention. He sought to establish a laboratory which operators and miners alike could feel was theirs and to which they could come for information and education. It was also his conception that this station should stop the waste in mining resulting from the inefficient methods employed and the excessive competition in the coal industry. To this end he foresaw the need of research laboratories for chemical and physical investigation of gases, explosives and mineral substances, the necessity of equipment for testing mine lamps and other machinery. Above all he knew that the work of the bureau would result in the training of thousands of miners in the use of rescue apparatus and in giving first aid to the injured.

The work at last is completed and the bureau of mines, in co-operation with the Pittsburgh chamber of commerce provided a program of events to fittingly commemorate the occasion. The ceremonies opened on Monday morning, Sept. 29, when the new laboratories 4800 Forbes street were thrown open for inspection. The dedicatory services were held at 10:30 a. m. on the lawn in the rear of the laboratories with Dr. Van H. Manning, director of the bureau, presiding. After invocation by Dr. S. B. McCormick, chancellor of the University of Pittsburgh an address of welcome was delivered by Hon. E. V. Babcock, mayor of Pittsburgh. Hon. Frank K. Lane, secretary of the interior, responded to the address and was followed by Horace B. Winchell, president of the American Institute of Mining and Electrical Engineers; John L. Lewis, acting president of the United Mine Workers of America, and Hon. William C. Sproul, governor of Pennsylvania. At the conclusion of the addresses Secretary Lane formally delivered the keys of the building to Director Manning.

Luncheon followed at the bureau of mines building and then the guests proceeded to the experimental mine of the bureau of mines at Bruceton, Pa., 14 miles from Pittsburgh. Upon arrival there a prearranged explosion of coal dust occurred in the experimental mine as a demonstration for the benefit of the visitors. After the explosion there was an inspection of the mine and the explosive testing plant. The guests returned to the city at 6 p. m. A general meeting was held at Carnegie Music hall at 8 p. m. under the auspices of the Pittsburgh chamber of commerce.

The new laboratories were open for inspection the entire day on Tues. Sept. 30. The elimination contests in the national safety first aid and mine rescue meet were held at Forbes field during the afternoon. A demonstration of the explosibility of coal dust was given at Forbes field at 5 p. m., and in the evening the chamber of commerce presented a pageant typifying the spirit of the mining industry. The final mine rescue contests and other events, including a pageant in the evening, were held on Wednesday, Oct. 1. The pageant consisted of symbolical figures typifying the mother earth concealing her children, which are the minerals.

NEW LABORATORY OF THE BUREAU OF MINES, PITTSBURGH, WHICH WAS FORMALLY DEDICATED SEPT. 29—RESEARCH WORK WILL BE CONFINED TO INVESTIGATION OF TYPICAL COALS AND NONFERROUS METALLURGY

DATA ON BELTS AND PULLEYS

By W. L. Tryon

VELOCITIES OF BELTS OR PULLEYS

(Continued from Data Sheet No. 302)

Dia. of Pulley	Velocity of Belt or Pulley in Feet Per Minute when Number of Revolutions Per Minute Are											
	300	350	400	450	500	550	600	650	700	750	800	850
11	864	1008	1152	1296	1440	1584	1728	1872	2016	2160	2304	2448
2	157	183	209	236	262	288	314	341	366	393	419	445
2½	196	229	262	295	327	360	393	425	458	491	524	556
3	236	275	314	353	393	432	471	511	550	589	628	668
3½	275	321	367	413	458	504	550	596	642	687	733	779
4	314	366	418	471	523	575	627	680	732	784	836	889
4½	353	412	471	530	589	648	707	766	825	883	942	1001
5	393	458	524	589	655	720	785	851	916	982	1047	1113
5½	432	504	576	648	720	792	864	936	1008	1080	1152	1224
6	471	550	628	707	786	864	943	1021	1100	1178	1257	1335
6½	510	595	680	765	851	936	1021	1106	1191	1276	1361	1445
7	550	642	733	824	916	1008	1100	1191	1282	1374	1466	1557
7½	589	687	785	883	982	1080	1178	1276	1374	1472	1570	1669
8	628	732	838	942	1047	1152	1256	1370	1466	1571	1675	1780
8½	668	779	890	1001	1113	1214	1335	1446	1558	1669	1780	1891
9	707	825	942	1060	1178	1296	1414	1531	1649	1767	1885	2003
9½	746	875	995	1119	1244	1368	1492	1617	1741	1865	1990	2114
10	785	916	1047	1178	1309	1440	1571	1702	1833	1964	2094	2225
10½	825	962	1100	1237	1375	1512	1649	1787	1924	2062	2199	2337
11½	903	1054	1204	1355	1506	1656	1807	1957	2108	2258	2409	2559
12	942	1100	1256	1413	1571	1728	1885	2044	2199	2356	2513	2670
12½	982	1145	1309	1472	1636	1800	1963	2127	2290	2454	2618	2781
13	1022	1191	1362	1533	1703	1873	2044	2214	2384	2555	2725	2895
13½	1060	1237	1414	1590	1767	1944	2120	2297	2474	2651	2827	3004
14	1100	1282	1466	1649	1833	2016	2199	2382	2566	2749	2932	3115
14½	1139	1329	1518	1708	1898	2088	2278	2467	2657	2847	3037	3227
15	1178	1374	1571	1767	1964	2159	2356	2553	2749	2945	3142	3337
15½	1217	1420	1623	1826	2029	2233	2435	2638	2841	3044	3246	3449
16	1256	1466	1675	1885	2094	2303	2513	2722	2932	3142	3350	3560
16½	1296	1512	1728	1944	2160	2376	2591	2807	3023	3239	3455	3671
17	1335	1558	1780	2003	2226	2448	2671	2893	3116	3338	3561	3783
17½	1374	1603	1832	2061	2291	2520	2749	2978	3207	3436	3665	3894
18	1414	1649	1885	2120	2356	2592	2827	3063	3298	3534	3770	4005
18½	1453	1695	1937	2179	2422	2664	2906	3148	3390	3632	3874	4116
19	1492	1741	1990	2238	2487	2736	2984	3233	3482	3731	3979	4228
19½	1532	1787	2042	2297	2553	2808	3063	3318	3574	3829	4084	4339
20	1571	1833	2094	2356	2618	2880	3142	3403	3665	3927	4189	4451
21	1649	1924	2199	2474	2749	3021	3299	3574	3849	4123	4398	4673
22	1728	2016	2304	2592	2880	3168	3455	3743	4031	4319	4607	4895
23	1806	2108	2408	2709	3011	3312	3613	3914	4215	4516	4817	5118

(Continued on Data Sheet No. 304)

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

DATA ON BELTS AND PULLEYS

By W. L. Tryon

VELOCITIES OF BELTS OR PULLEYS

(Continued from Data Sheet No. 303)

Dia. of Pulley	Velocity of Belt or Pulley in Feet Per Minute when Number of Revolutions Per Minute Are											
	300	350	400	450	500	550	600	650	700	750	800	850
24	1885	2199	2513	2827	3142	3456	3770	4084	4398	4712	5027	5341
25	1964	2290	2618	2945	3273	3600	3927	4254	4582	4909	5236	....
26	2042	2384	2723	3063	3404	3744	4084	4425	4765	5205	....	....
27	2120	2474	2827	3181	3534	3887	4241	4594	4948	5301	....	....
28	2199	2566	2932	3299	3665	4032	4398	4765	5131	....	....	....
29	2278	2657	3037	3416	3796	4176	4555	4935	5314	....	....	....
30	2356	2749	3142	3534	3927	4320	4712	5105	....	....	....	....
31	2435	2841	3246	3652	4058	4464	4870	5275	....	....	....	....
32	2513	2932	3351	3770	4189	4607	5026	....	....	....	....	....
33	2592	3023	3456	3887	4320	4751	5184	....	....	....	....	....
34	2670	3116	3560	4005	4451	4896	....	....	....	....	....	....
35	2749	3207	3665	4123	4582	5040	....	....	....	....	....	....
36	2828	3298	3770	4241	4713	5184	....	....	....	....	....	....

Dia. of Pulley	——Velocity of Belt or Pulley in Feet Per Minute when Revolutions Per Minute Are——											
	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
2	471	524	576	628	681	733	785	838	890	943	993	1046
2½	589	655	720	785	851	916	981	1046	1112	1178	1244	1309
3	707	785	864	943	1021	1100	1178	1257	1335	1414	1492	1571
3½	825	916	1008	1100	1192	1283	1375	1467	1558	1650	1740	1832
4	941	1046	1151	1255	1359	1464	1568	1673	1777	1882	1989	2094
4½	1060	1178	1296	1414	1531	1649	1767	1885	2003	2120	2238	2356
5	1178	1309	1440	1571	1702	1833	1964	2094	2225	2356	2487	2618
5½	1296	1440	1584	1728	1872	2016	2160	2304	2448	2592	2736	2880
6	1414	1571	1728	1885	2042	2199	2357	2514	2671	2828	2984	3142
6½	1531	1702	1871	2041	2211	2381	2552	2722	2892	3062	3235	3406
7	1649	1832	2015	2198	2382	2564	2748	2931	3114	3298	3482	3665
7½	1777	1963	2159	2356	2552	2748	2945	3141	3337	3533	3731	3927
8	1885	2094	2303	2513	2722	2932	3142	3350	3560	3769	3979	4188
8½	2003	2225	2448	2670	2893	3115	3338	3561	3782	4005	4228	4451
9	2120	2356	2592	2827	3063	3298	3534	3770	4005	4241	4476	4712
9½	2238	2487	2735	2984	3233	3482	3731	3979	4228	4477	4725	4974
10	2356	2618	2880	3142	3403	3665	3927	4189	4451	4712	4974	5236

THE FOUNDRY DATA SHEET, OCTOBER 1, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Castings for Ship Construction-XI

Method of Constructing Patterns and Coreboxes for Shaft Bracket for Small or Medium Vessels — The Two Arms and the Middle Table Piece are Constructed Together

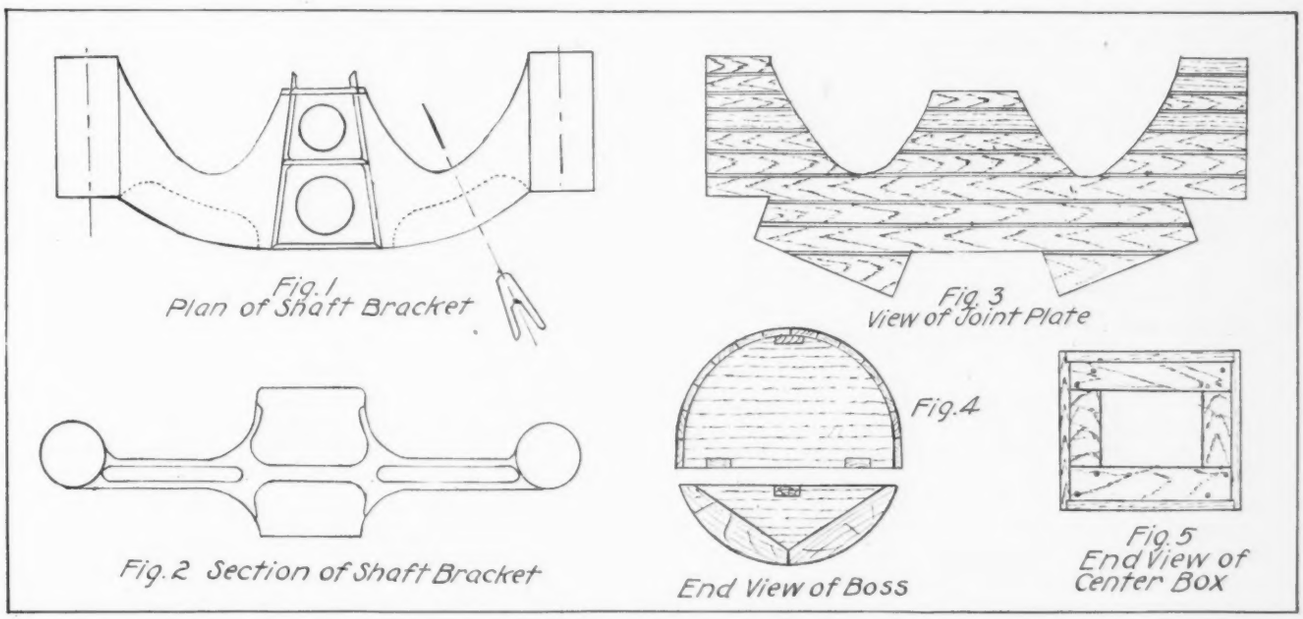
BY BEN SHAW AND JAMES EDGAR

THE shaft bracket shown in Figs. 1 and 2 is different in design from those already described. Instead of palms or flanges, the casting is usually supported by the stern frame casting and the shell plates. It will be noticed, also, that instead of two separate castings the bosses, the two arms, and the middle table piece all are one large casting. This is a form of bracket more common on small or medium size vessels. The design is equally applicable to large ships, but the casting is clumsy and difficult to make. If made for large work the center piece is split on the center line, each boss and arm being separate castings, bolted together.

The construction of the job differs materially from the palm type of bracket. It might be possible to make a skeleton pattern but this would not be profitable. It would take longer to build the curved ribs which enclose the center spaces, and which would have to be left loose, than it would to cut the large fillet on the outside from solid lumber and make coreboxes. It would also take longer to build the arms so that the molder could make a core from them, than it would to make them solid with a print and use a box. The relative quantity of lumber required in each method is important. There probably would be more timber used for a skeleton pattern, because much would be cut to waste and the coreboxes can be so made that little timber will be needed for them. However, more important than either the labor or lumber cost, is the quality of pattern produced by each method. Certainly, the solid pattern is preferred on this basis of comparison. In a skeleton pattern the heavy bosses would not be properly supported by the narrow arm end and there would be a grave danger of them breaking. Even if this did not occur the pattern might become warped in the sand with the consequent loss through an inaccurate casting. In this article, therefore the solid pattern and coreboxes will be considered.

The cores through the bosses are not shown in Figs. 1 and 2 because they are similar to those already explained, and the same methods of making the cores would be adopted. Several templates would be supplied for this job, for the arms, and also for defining the shape of the center, but the important template for the patternmaker would be that giving the contour of the bracket corresponding to Fig. 1. In all probability it would be the same as the drawing but it might have been modified, and, as usual, the pattern sizes would be taken from the templates. The large template is placed on a drawing board or on the floor and scribed around. The contraction then is added and it may be advisable to set down a section of the arm on top of this plan, and also one or two sections across the center table.

It is more convenient for the molder, if the pattern is made in two halves, the joint being through the center of the arms. It is essential that the whole pattern be built on joint plates. The patternmaker has to decide between three methods, a half lapped frame may be made, one thickness boards may be laid edge to edge and hardwood battens inset to bind them together, or a plate in two thicknesses may be built. The obvious disadvantage of the half-lapped frame is the difficulty of securing strength owing to the irregular shape. It is not possible to drive nails through from end to end. The two thickness plate is not commendable on the principle that it is bad prac-



FIGS. 1 AND 2—TWO VIEWS OF A DIFFERENT DESIGN OF SHAFT BRACKET FIG. 3—VIEW OF JOINT PLATE FOR SHAFT BRACKET FIG. 4—END VIEW OF BOSS FIG. 5—END VIEW OF CENTER BOX

tice as a rule to have side grain and end grain on one perpendicular, as the side grain shrinks and the result is unsightly and troublesome in the foundry. In the present case, however, strength is the important quality to be desired in the frame as on this factor depends the rigidity of the pattern. Fig. 3 is a sketch of this plate.

The lumber should be kept the full width of the boards and left with open joints. The illustration shows the face of the plate with the lumber running the full width. The other thickness would of course be screwed across. When the plates are both screwed they may be nailed together temporarily, dowelled, and the shape set out and cut. The main center line and the boss centers should be squared over on both sides of the plates. The parts of the plates A-A, Fig. 3, which support the prints should be wide to balance the cores. It will be necessary to trim off the ends of the plates, after the lagged barrel pieces have been screwed to the plates, because the centers of the bosses are not on the same plane as the pattern joint. If, however, the plate is made to the finished length, it is wise to make a large part of the barrel square from the center line as shown in Fig. 4, and the small portion full the size at the outside edge so that they can be trimmed. It may be possible for patternmakers to work so accurately that no trimming of edges is necessary, but it is safer to leave a little for final finishing. The large portion of barrel is made like an ordinary full barrel with checked stays and lagging, but the small part can be planed from solid wood. If it is rather large for this the smaller end may be made as illustrated from end grounds, with pieces screwed to them, and a stay on the face. The lagged parts can be screwed through the plate, dogs being used to hold them while turning over, or the screwing can be done from beneath.

It would not be practical to construct the center piece and both arm fillets as one piece. It must be borne in mind that the deep side of the pattern is in the bottom of the mold, therefore the print has to be on this side. No cope print is needed, as the cores are steady without one, due to the large bearing which the circular holes in the center plate afford. The best way to construct the center is to make a box similar to those shown in Figs. 5 and 6. This box is made the full width of the bracket in length, and across, it follows the inside of the line of metal. Thus the small portions of the cross ribs which are carried to the outside of the metal may be nailed or wired on afterwards so that the molder can leave this in the sand until after he has drawn the main pattern.

The grounds for the box may be half-lapped frames about 2 x 4 inches, nailed together. Fig. 5 illlustrates this construction. Similar boxes are necessary for both the top and bottom.

If the work is small the blocks for the arms may be made from solid wood or from thicknesses glued together. However, if the parts are large, they should be constructed similarly to those shown in Fig. 7, where a block is shown set upon the joint plate. The print should be built separately. It should be noted that in the present design the angle of the arms is uniform from the end of the large fillet which connects them with the table center to the point where they join the boss. This leaves a piece of the joint plate uncovered forming what is equivalent to a rib to the face of the boss. More often, however, the angle is lengthened so that the shape of the arms is different along the entire length, in which case it would be practically impossible to do other than make them from solid lumber, joined edge to edge. Most of the segments in this case may be lightened before being built.

The arms built as shown in Figs. 7 and 8, consist of two grounds and a circular segment portion on which a top plate or plates are screwed. The top plate projects a considerable distance beyond the ground at the barrel end, and the fitting shape should be cut so that when the arm blocks are laid on the joint plates, no chalking and fitting will be necessary. This is a matter of simple geometry. Two views as shown in Fig. 9 are laid out on the drawing board. The line *AB*, Fig. 9, corresponds to the angle of the arm joining the barrel. Three or four lines are projected to the front elevation and the distances *AB*, *CD*, *EF* and *HJ* are determined. Fig. 10 is a plan showing both barrels and one of the arms fixed on the joint plate.

Making the fillets is difficult. If large, they are built as shown in Figs. 11 and 12, and if smaller they are glued up solid as shown at *A*, Fig. 13. With either method the blocks should be fit-

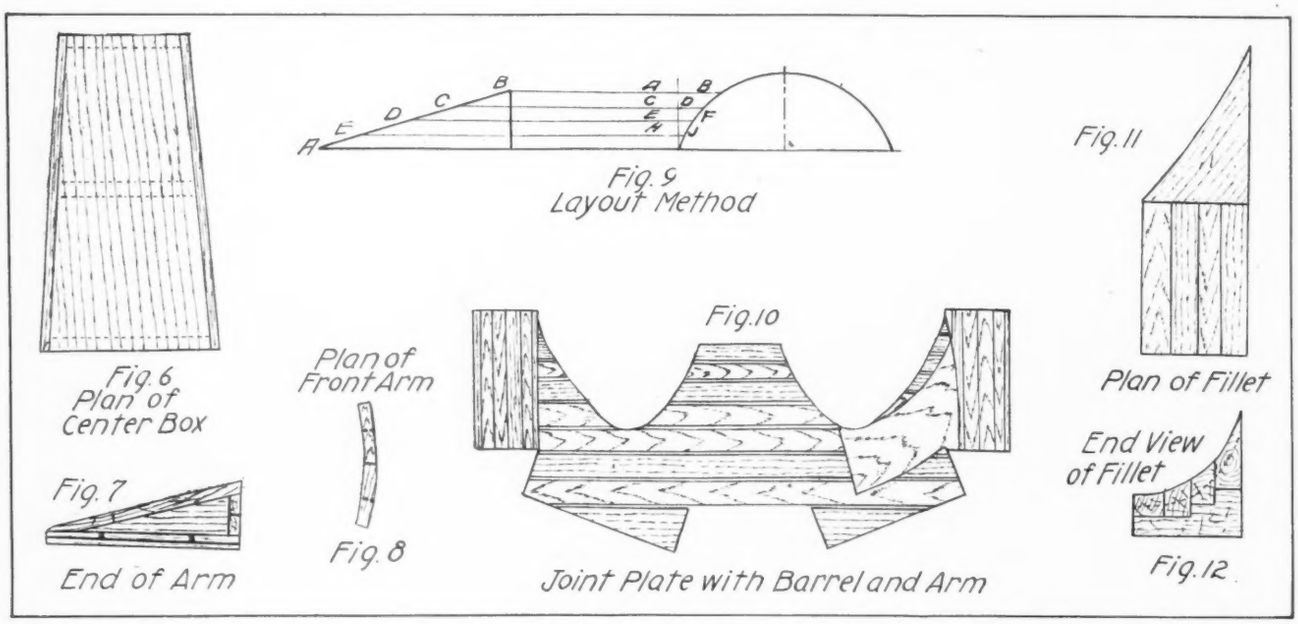


FIG. 6—PLAN OF CENTER BOX FIG. 7—END VIEW OF ARM FIG. 8—PLAN OF FRONT OF ARM FIG. 9—METHOD OF LAYING-OUT THE ARMS
FIG. 10—JOINT PLATE WITH BARRELS AND ARM FIG. 11—PLAN OF FILLET FIG. 12—END VIEW OF FILLET

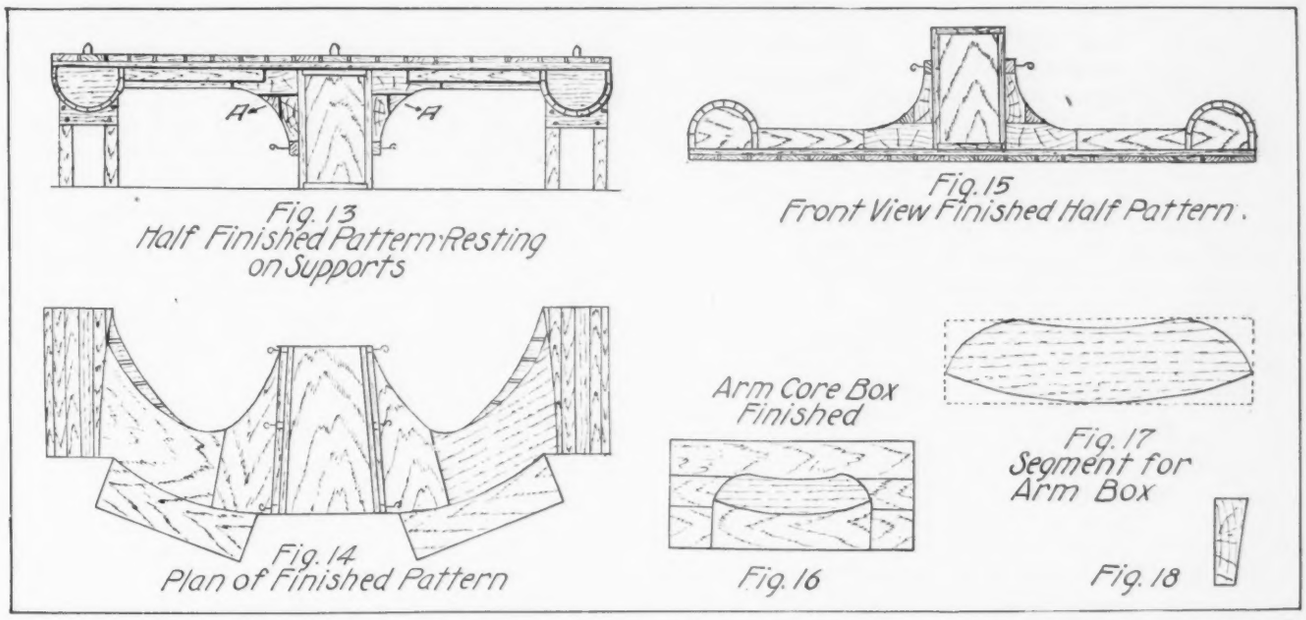


FIG. 13—FINISHED HALF PATTERN, SHOWING THE SUPPORTS FOR THE BARRELS FIG. 14—PLAN OF FINISHED PATTERN FIG. 15—FRONT VIEW OF FINISHED PATTERN FIG. 16—FINISHED ARM COREBOX FIGS. 17 AND 18—TWO VIEWS OF SEGMENT FOR ARM BOX

ted into correct position before they are cut to shape, when lines can be drawn off the arms. It is not possible, of course, to build that part of the fillet beyond the arm proper which is shown in Fig. 11.

The ribs that project beyond the ends of the center box are best left until the two halves are together to ensure their being in line top and bottom. The prints for the arms are made solid or boxed up according to the thickness. As a general rule when work is less than three inches thick, it is well to box it up. If these prints are made in this way an inch plate will do for the top with a front of the same thickness and two thicker ends. It is always good practice to make the grounds much thicker than lagging or staves because they have to take screws and also because they must be more rigid and stable. The ends are checked into the sides, that is the sides are recessed to form a shoulder, which prevents the ends from being knocked in.

The pattern now is ready to turn upside down to build the other half on top. It is not essential to build the one half on top of the other, and if sufficient men are available the two halves may be made concurrently, as long as the joint plates are made together. It is always necessary, however, to try the two halves together before the pattern goes to the molder, so that faces can be tested with a straightedge. There is also less danger of details being forgotten when the whole work is seen together. Before the halt pattern is turned over, however, supports must be provided to carry the barrels, as shown in Fig. 13. Accuracy is necessary for these supports as the joint plates must be kept straight while the second half is being built. If the pattern is built with a twist it is almost impossible to rectify it after it is finished. To safeguard against this when building such a large pattern the joint face of the completed portion should be sighted with parallel srtaightedges.

It is not necessary to say much

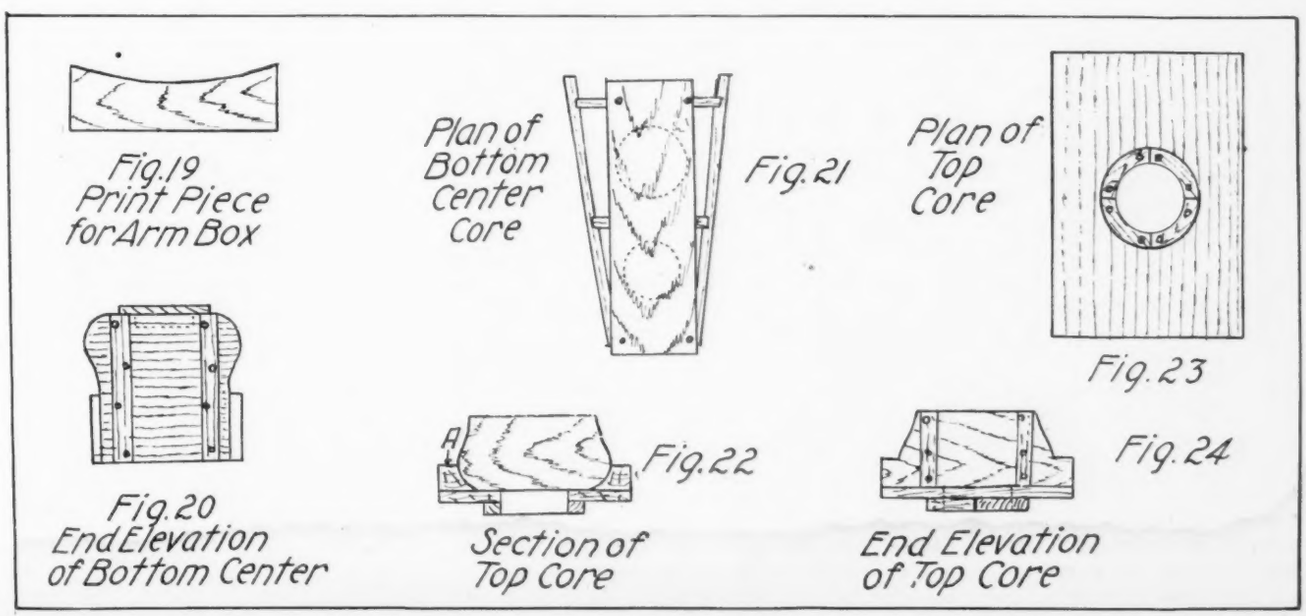


FIG. 19—PRINT PIECE FOR ARM BOX FIG. 20—END ELEVATION OF BOTTOM CENTER CORE FIG. 21—PLAN OF BOTTOM CENTER CORE FIG. 22—SECTION OF TOP CORE FIG. 23—PLAN OF TOP COREBOX FIG. 24—END ELEVATION OF TOP COREBOX

about the second half as it is similar, although more shallow.

The center box for this half is made to the top of the ribs as no print is needed. The ribs at the end of the center table may now be screwed on. As it is possible that the molder will leave the ribs in the sand when he draws the pattern, no driving nails should be used to fasten them in place. Although they are not shown in the plan of the finished pattern, Fig. 14, or in the front elevation, Fig. 15, prints must of course be made for the ends of the barrels.

Identifying Marks

The central block in the shallow half of the pattern should be painted black or such a color as the prints are painted to signify that the core is on the outside. Much good time is wasted in the foundry measuring coreboxes to get thicknesses, which should be given by the patternmaker.

The easiest method for keeping the half pattern rigid while conveying it to the foundry, is to make two long bars about 3 x 9 inches in section, and screw them to the joint plates. In all probability the molder will leave them on the pattern while molding the bottom half.

The coreboxes are not difficult to make. They are four in number, one being necessary for the arm, and three for the table. A half box is all that is required for the arm core. Fig. 16 is a plan of this box. When the bottom plate has been made, a board at least ½ inch more than half the thickness of the print should be screwed to it, and cut to the counter of the core. If the box is made only for half the core depth, there will be a feather edge on the piece shown in Figs. 17 and 18. The taper of this piece should be planed while the timber is rectangular and the core shape afterwards drawn on it. A piece like Fig. 19, ½ inch thick completes the box. The two half cores are made and glued together in the foundry.

The table core should be made in three boxes. If it were made as one core, it would be difficult to make and would be too fragile to handle. It is really simpler to make the portions of the core above and below the middle plate separately, connecting them by a socket joint formed by placing prints in the bottom corebox, projecting circular cores being made in the top boxes. The whole of the bottom core, the core that is with the main print is undivided, but the top core must be in two parts as there is no print and a middle dividing rib must be provided. The two cores might be made in one box, but it is inconvenient in the foundry, and the small amount of extra labor involved in the patternshop, making two boxes, is well worth while. Figs. 20 to 24 give the different details in the construction of the top and bottom boxes. Boxes are not always so made in the patternshop that the molder can use his lifter without trouble. The most suitable grids also seldom are considered but they should be, and these boxes are designed with this object in view. The one style of box is as cheap as the other.

The bottom box consists of two sides and two ends, the ends being let into the sides. The sides are carried up to the beginning of the curve. It is not necessary to have a bottom on this box.

On the top and resting on the ends is a bar to carry the print. This bar should be dowelled so that it can be replaced without trouble. There is a little more work involved in making the other boxes. Bottoms are necessary and the circular holes have to be cut through these bottoms. The rings of segments on the underside of the plates are provided to save timber and make the boxes lighter. Blocks (*A*, Fig. 22) must be made and screwed to the bottom. These make the core to the center of the radius, and beyond this can be struck off in the same way. The ends of the box (*B*, Fig. 24) are made sufficiently long to enable them to be screwed to the ends. In all these boxes it is advisable to batten the ends, and it may be necessary to fit brackets against them to prevent them from being rammed outward.

Selecting Sands for Cores

Question—We would like to obtain a list of core-sand mixtures covering all kinds of mixtures and for all thicknesses of metals.

Answer—It is not necessary to have such a list of core mixtures as mentioned in the query as it would lead to a lot of changing of sands and binders. When the reasons for using different sands is known it is always easy to make up mixtures to suit the class of castings being made. Two kinds of sands are used in core making; sharp sand and molding sand. The sharp sand carries off the gases better than molding sand as the latter contains alumina, is finer in grain and packs closer. More molding sand is used in the mixture for small cores because the castings must be smoother and, being small, little gas is generated. For this reason the molding sand is satisfactory as far as carrying off gas goes, and as it packs closer there are fewer openings between the grains into which the metal could flow and produce roughness on the surface of the castings.

Molding sand also forms an important constituent of cores that are made in the round, because, unless dryers are used, such cores must be handled green in transferring them from the core box to the core plate. They must, therefore, be strong before drying, and molding sand is an important factor in giving the sand strength. The binder also figures in the strength of cores made in the round. A binder which is soluble in water makes a stronger green-sand core than an insoluble binder; thus oil makes a weak core before being baked. Knowing these facts it is not difficult to select a sand mixture and binder suitable for the kind of castings specialized in. A mixture which would be perfectly satisfactory for light cores would be useless for heavy ones.

A foundry making small castings, the cores for which are mainly made in the round should select a core mixture containing considerable molding sand and a dextrine binder. If the cores are small and thin, but have to be very strong when dried, such as cores for trolley and splicer ears for overhead electric railroad work, oil is the best binder to use. There will be no difficulty about getting the cores out of the boxes and standing them on the plates, provided plenty of molding sand is used in the mixture.

For a heavy casting more sharp sand must be used. In some cases no molding sand may be mixed with it. To prevent the metal from entering the structure of the core, it must be protected by a coating of some infusible substance, such as plumbago, and the heavier the casting due to thickness of wall, the thicker must be the coating of plumbago. In some cases it is necessary to rub the coating onto the core with the fingers.

The amounts of sharp sand and molding sand in a core mixture will vary from all sharp sand to a mixture of 3 parts molding sand to 1 part sharp sand. For medium work use 1 part sharp sand to 2 parts molding sand. These are usually made up by taking 1-3 old molding sand; 1-3 new molding sand and 1-3 sharp sand, mixing and adding the binder. In the case of oil binder, use about 1 part oil to 32 parts mixed sand; flour 1 part to 10 of sand; gluten 1 part to 35 of sand; dextrine 1 part to 25 parts sand.

The Acme Silica Co., Ottawa, Ill., has opened new silica deposits at Sheridan, Ill., under direction of B. I. Larsen, general manager.

Using a Corebox Machine on Shallow Work

By William Ballantine

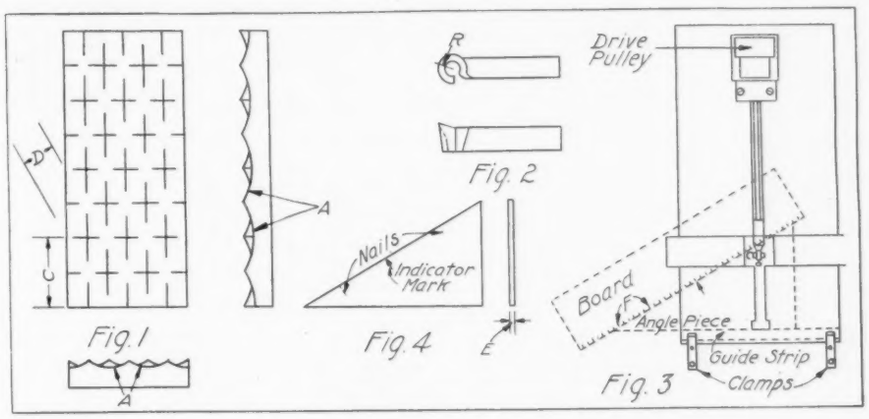
Notwithstanding the acknowledged efficiency of the machine which has been developed for shaping the interior of coreboxes, it is surprising to find that very few pattern shops have yet installed one as part of their regular equipment. It is still more surprising to observe the attitude of many patternmakers toward it. They seem to think it is something mysterious and therefore infinitely more dangerous on that account than any other machine used in the pattern shop. Furthermore there seems to be an impression that an expert is needed to operate it.

In the writer's opinion these views are entirely misleading. It is not as dangerous a machine to operate as a rip saw, and instead of an expert, an apprentice with very little instruction can turn out successfully the most difficult coreboxes. The machine not only makes a more perfect corebox than could be turned out by any patternmaker, but it does it in about 7 per cent of the time. For instance it will cut out a corebox in 20 minutes that would engage a patternmaker half a day if he had to gouge it out by hand.

The following description shows a departure from the orthodox method of using the machine and proves how adaptable it is for making a style of pattern which is fairly common in all jobbing foundries.

Some time ago we were called upon to supply a rush order of diamond plate door stills. Not having time to send to the factory for stock diamond plate it was up to us to make it. The corebox machine was suggested by the patternmaker to whom the job had been given. We tried out the suggestion and to our surprise we got a better plate than we had ever obtained by hand.

Fig. 1 shows a top, end and side view of the plate. It also shows that the bottoms of the grooves were rounded and the tops of the diamonds were quite sharp. This feature was appreciated in the foundry where the pattern molded perfectly. Fig. 2 is a detail view of the cutter used in making the grooves. The radius *R* is one-half the width of the groove. The first step was to lay out on a suitable piece of board the desired diamond, Fig. 1. This gave the angle for the jig or angle piece, Fig. 4. The jig was a piece of lumber about the same thickness as the board on which the diamonds were to be cut. It was used to hold the board at the proper angle while it was being pushed across the cutter in the direction indicated by the arrow in Fig. 3. Two nails were driven in the hypothenuse of the jig and were left projecting just far enough to keep the pattern from sliding during this operation.



SIMPLE AND EFFICIENT DEVICE FOR MAKING DIAMOND PLATES

A guide strip, shown in Fig. 3, was clamped across the top of the table at one end and served for a guide for the jig. The indicator marks were to show how far to move the pattern after each cut.

Fig. 3 is a view of the top of the corebox machine with the fence removed. In making diamond plate, the work is moved across the machine instead of lengthwise, as in making coreboxes. The dotted lines show the position of the guide strip, the angle piece and the pattern. The pattern was marked off on the edge *F*, Fig. 3, with dividers the same distance as *C*, Fig. 1. The board was moved one mark each time a cut was taken off. One mark was always kept at the indicator mark. After all the cuts were made one way across the board, the angle piece was reversed and the cuts taken the other way. Diamond plate made this way saved both time and money and the diamonds were all perfectly uniform in shape, size and depth.

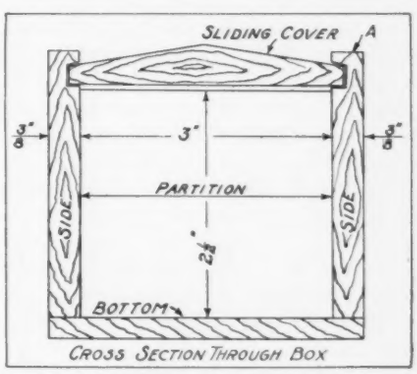
Order and System Save Patternmaker's Time

By M. E. Duggan

Brads, screws and nails are used every day in the construction of patterns. To use care in storing these supplies is considered by many patternmakers to be a waste of time. Nine times out of ten, however, those who scoff at order and arrangement are those who go every day to other departments or to fellow workmen to borrow set-screws or wire nails, because they cannot find those which they desire in their own disordered supplies.

The box which is shown in the accompanying illustration, I find to be most serviceable for holding brads or wire nails. The idea that "any old box" is good enough for nails is wrong. The careless patternmaker who has this idea is the one whose bench is a junk pile for all kinds of odds and ends. Belt lacing, leather fillets, wax, chalk, washers and jumbled packages of nails and screws litter the top and the drawers of his bench.

The box is 37 inches long, 3 inches wide and 2½ inches deep. It is partitioned into 12 compartments each large enough to hold a pound of brads or wire nails. Each small box has an individual cover, except one box which is always open. In other words, there are 11 single slide cov-



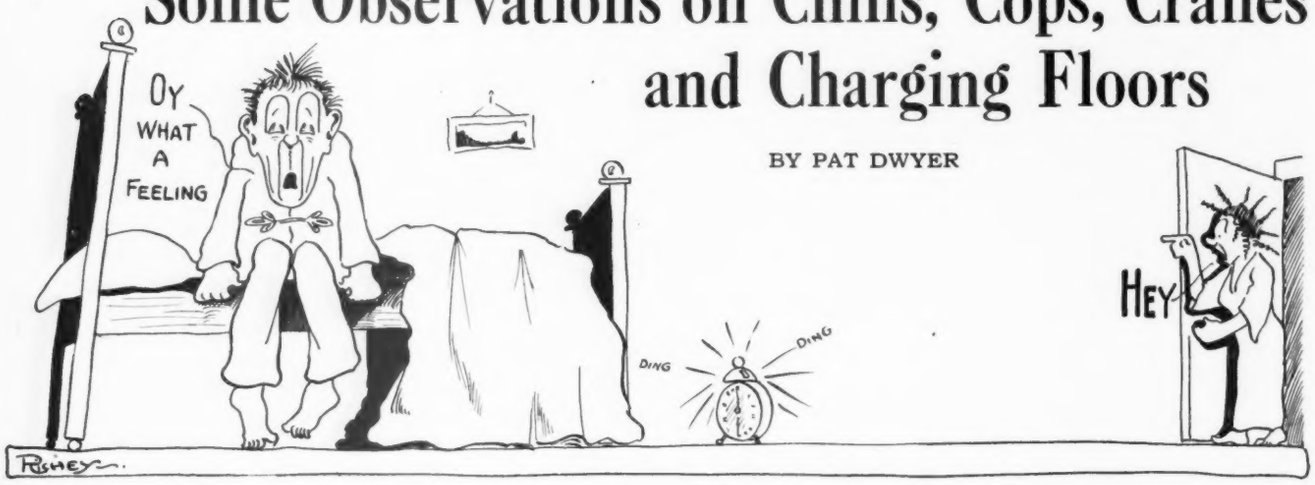
EASILY MADE SMALL BOX FOR NAILS, SMALL SCREWS AND BRADS

ers. The size of the screws or brads contained in each box is marked on the top edge as indicated at *A*.

When a particular size nail or screw is wanted, the box edge indicates where it will be found. The covers then are slipped back together, allowing the one compartment to remain open, namely that which contains the size wanted. The others all are closed. If part of the nails or screws are not needed it is a very matter to drop them into the proper compartment.

Some Observations on Chills, Cops, Cranes and Charging Floors

BY PAT DWYER



ONE morning I awoke with a light head and a sore throat. I lay for a while debating whether I should get up or not. I had almost persuaded myself that a few minutes more or less would not make any difference when I commenced to sneeze. That settled the argument. A person can not sneeze comfortably in bed. If you lie on your face, you smother, and if you lie on your back, you need an umbrella. Then, too, the baby slept in a crib alongside and I was afraid I would wake her and believe me that is something else altogether.

I crept softly out of bed and putting on just enough clothes to get by the censor, I retired to the bath room to shave and sneeze as much as I pleased. I soon found that, like every other form of pleasure which is free, a little goes a long way. I finished shaving and dressing and went down stairs but found that I could eat no breakfast. My stomach felt as if it was closed for repairs, if you know what I mean, and I felt no interest in the date of re-opening.

The lady who smiles at me (sometimes) across the breakfast table is a firm believer in the theory that as long as a man is able to eat he can be sent out to work; but if he cannot eat, then there is the gravest cause for alarm. "I think you had better stay home today," said she. "I will send for Dr. Squills, he will give you something to fix you up, and besides there are a few little things I want you to do around the house.

"Woman," I said, "I will stay home and I will take some of Dr. Squills essence of bitterino but—I will do no work. Little I thought when I was courting a certain dimpled maid a few short years ago that she would develop into a hard hearted creature with no pity for a dying man."

She laughed at me. "I had more than dimples in those days," said she, "I had the most childlike faith and used to believe all you told me, but now—well I have never been to Missouri—but you have to show me just the same."

What could a man do with an argument like that? Nothing. That is what I did.

The doctor telephoned that he could not come up until the evening unless the case was very urgent. I told him I had the "flu" and if he let me die from neglect I would come back and sit on his bedpost at night and make faces at him.

"They never come back from where you are going," said he, "and besides I am never in bed at night." Then becoming serious he continued, "Do you know, I have not had a night's sleep in bed for weeks. But, I'll be out to see you this afternoon. I think from the sound of your voice that you will last that long."

I crept upstairs and into bed and for two weeks I did not care whether my name was on the payroll or not. The doctor called on several occasions and told my wife how nice she would look in widows weeds, told me that I needed to sweat a little more and I would be all right.

When I was a young man I had worked in some hot shops, I put in one summer season on the drydock in Farrel's and another closing cylinder molds in Baldwin's and I thought I knew what sweating meant. I found that perspiration and I were almost strangers. The doctor gave me a box of small tablets and whatever kind of googum was in them, they made me feel like a slice of watermelon in the hands of one of our colored fellow citizens.

I think R. Kipling must have had a flu victim in mind when he dashed off that description of the lady, you know the one I mean, "a rag, a bone and a hank of hair." That was all that was left of men when I finally got up one day and managed to get down stairs by hanging on to the balustrade. The doctor called in the afternoon and gave me the O-O and a cigarette.. "Let me see you smoke that," said he, "and I can tell better what are your chances of an ultimate re-

SHE DEVELOPED INTO A HARD HEARTED CREATURE

covery." I must have convinced him that I was going to stay on this little old earth for a while for he said he would have the druggist send me out a bottle of tonic. The bottle arrived the next day. It was strong medicine and before I had it finished I was certainly a new man, but bitter—I have spent many happy hours mentally revolving fiendish forms of torture which I would like to inflict on people that I do not like but that medicine suggested new and excruciating forms of which I had never dreamed.

The members of the family keenly enjoyed watching the contortions when I swallowed the dose, but having arrived at the age of discretion they politiely tried to suppress any evidence of great pleasure. There was one exception, a young hero about four years old. Whenever he saw me reaching for the bottle he would attract everyones attention by yelling: "Look quick, look quick, papa is going to make monkey faces and kick his foot on the floor." It was great fun for them while the bottle lasted.

One day while convalescing I walked down the street on which Bill's shop is located and finding the door open walked in. I did not see any sign of Bill so I strolled over near the cupolas to examine a feature of the charging floor which looked new to me. While standing there the manager passed me without a sign of recognition. He was one of our modern highly developed young captains of industry, curt speech—valuable time—look at his watch every other minute—you know all that modern bunk affected by some to impress the spectator that they are full of pep and energy, regular human dynamos. I know that it sounds rude to say that many of them are filled with prunes and piffle but truth is mighty and it is a pleasure to indulge in it once in a while. I had a speaking acquaintance with him outside the shop but of course it would never do for him to recognize me during business hours. Speaking to me might mean the loss to him of 60 of those diamond seconds. I had half a mind to flag him just for the pleasure of seeing him pull all the sterotyped stuff: Sudden stop—surprised look—artificial smile of welcome—"How are you?" — pull out the watch, —"Well I have to get right back to the office, goodbye." Instead, I politely turned my back and gazed right hard in the opposite direction until I thought he was safely out of sight. While thus musing on the peculiarities of some human beings I saw one of the guards approaching at a dead-and-alive pace. I knew the fellow, in fact he had worked for me one time, so I greeted him pleasantly. Did it have any effect on him? It did not. He was swinging his billy when he approached, he now tucked it under his left arm, held out his right hand and in that insolent tone which many acquire when they put on a uniform, he asked me if I had a pass. Just then I saw Bill approaching, I waited until he arrived and passed the case over to him.

THAT INSOLENT TONE OF UNIFORMED AUTHORITY

"Personal friend of mine," said Bill to the lad. "Beat it." "He can't stay in here without a pass!" protested Authority with a capital A.

"See here," said Bill, "We ain't livin' in darkest Russia, neither are we in a penitentiary; we are in a plain American shop in a plain American town and under these circumstances when a friend of mine comes in to see me he is going to stay, pass or no pass. On your way. I don't like the way you comb your hair."

"Those are the kind of fellows who make me turn bolshivicky," said Bill to me, "they have neither brains, ambition or energy and by their laziness, insolence and assumption of authority they create a feeling of hatred in the men not only for themselves but for the company which employs them.

"The system of issuing passes to visitors is right. It discourages indiscriminate visiting. If you had gone to the office and told them that you were a personal friend of mine they would have issued a pass to you and you could have come right in. The fact that I recognized you when you appeared without a pass would satisfy any person in authority but of course this bird with the single track mind could not see it that way."

"Perhaps I had better fly while the flying is fair and open," I said; "if that hill billy comes back it may get you in bad."

"Don't worry about me," said he, "the boss may be queer but he is not crazy. He is always willing to listen to an explanation and since he convinced himself some time ago that I tell the truth whether I am right or wrong he places considerable confidence in what I say."

"There is a nice point there," I said, "whether a man is justified in making an equivocal answer sometimes, but I am in no condition to put up an argument today. I just came in to see you and to notice whether you had made any improvements in the place since I was here before."

"I should like to draw your attention to one improvement," said he, "right there in front of the cupolas."

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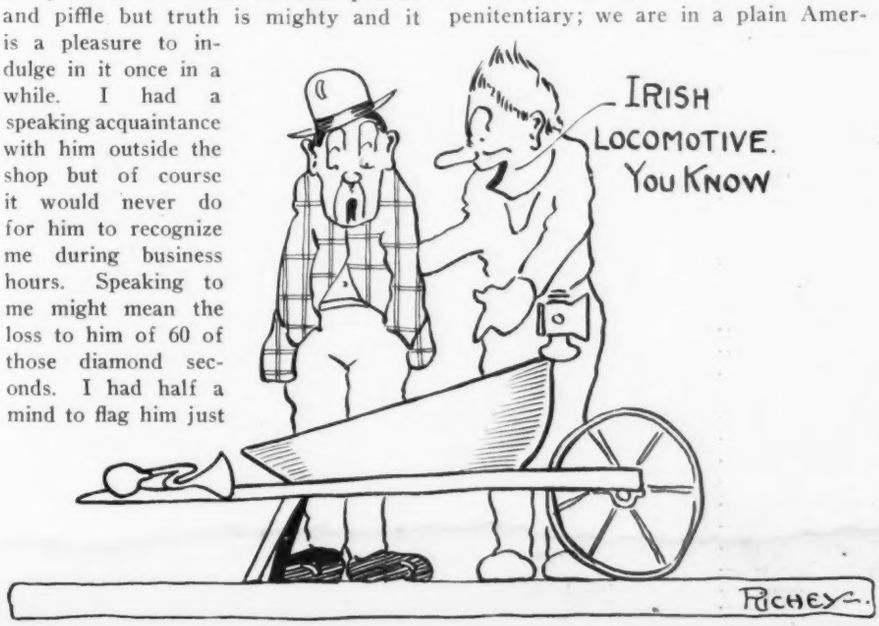

THE HIBERNIAN COUPE BECOMES OBSOLETE

THE FOUNDRY

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Tell Them About It

FIFTY thousand iron molders are on a strike in Great Britain. There is no question of collective bargaining, recognition of the union or anything of that sort at issue—these problems were settled long ago in the old country, presumably to the satisfaction of the workers. The chief subject of the present controversy is the question of payment by results, in other words the piecework system. The unions demand a uniform scale, applicable alike to the good workmen and the drones. The deadening effect of such a system of wage-paying on production is obvious. We may expect some such movement in this country before long. Today piece rates are scientifically adjusted, rigidly maintained and under modern conditions, payment by results is the only just system of rewarding workers. It insures the man with superior skill and industry being paid according to his deserts; also it tends to eliminate the inefficient and the shiftless. Furthermore, the piecerate system is a powerful stimulant to production—and greater production is the key to the solution of most of our economic troubles at the present time. Employers owe a duty to their men to teach them the fundamentals of business economics so they will understand why the cost of living cannot be reduced until more commodities are produced for general consumption.

Why a Tariff?

FOUNDRYMEN should interest themselves in legislation recently introduced in the house of representatives for the purpose of increasing the duty on Ceylon plumbago, graphite ores, imported crucible clays, etc. If these bills are passed, serious cost to the foundry business will result since inevitably prices on foundry facings, crucibles, etc., would be materially increased. Furthermore, business men and international bankers who take a broad view of affairs, are concerned over the great excess of exports over imports at the present time. The only way to remedy this situation is to encourage imports of materials calculated to benefit the industries of this country. It is estimated that fully 80 per cent of the graphite used for foundry facings is imported and up to date no deposits have been discovered in the United States equal in quality to the foreign variety. There is no opportunity, therefore, under the proposed tariff, to substitute an equally good domestic article. These facts apply to high grade crucible clays as well as graphite. Foundrymen who used crucibles during the war have a vivid recollection of the troubles they experienced, and the conditions which existed then constituted no reflection on the crucible manufacturers, who in fact achieved unusual results in the face of tremendous obstacles. Now, however, when the highways of foreign commerce are again open, it would seem that the placing of a tariff on these necessary foundry raw materials would result not only in injury to the foundry industry but to our entire fabric of international trade. Under modern tariff theories, most everyone is agreed finished goods may be protected to stimulate home manufacture, but raw materials, especially when they cannot be duplicated in the home country, should be entered free of all duty and restriction in order to further stimulate domestic industry and manufacture.

Trade Outlook in the Foundry Industry

THE first few days of the steel strike found foundries in general unaffected and confident that the situation will be righted before the foundry industry is seriously interfered with through the lack of raw materials. The very fact that the first few months of the year proved lean in orders has created a reserve of iron, and the past month's revival has brought a steady buying movement that finds most plants supplied for at least a month, while many have stocks which will carry them through until the first of the year. Gray-iron shops which handle jobbing work, within the past month have experienced such an increase that in many cases several months' supply of iron has been secured and stored within their own yards.

Malleable Fortified

Malleable plants all are supplied for at least 30 days, and all those which have facilities, have stocked pig iron heavily. Malleable operations have remained steadily at about 70 per cent of rated capacity, but the steady increase in demand finds many refusing orders due to the shortage in available labor. Iron, however, has been bought to supply the high percentage operation which has been expected, and therefore the supply on hand is more than ample to care for needs through the next few months. No direct effect on the price of foundry raw materials has been noted up to the present time. Inquiries, in many cases, have been held in abeyance by northern furnaces, pending more settled conditions, and in some northern districts so few furnaces supplying foundry iron are in blast that difficulty is experienced in placing orders. Indications of a buying movement in foundry iron which seems likely to approach the high level established in July are noted in the East. The offering of 1920 iron at the price range now in force is responsible for this rush of orders. The orders placed in the Boston district during the past week have ranged from a small tonnage to 4000 tons in a single contract. Stove foundries alone have taken over 1000 tons in this district and machine-tool and special machinery manufacturers are active inquirers. The strike does not seem to have affected the market in the East to an appreciable extent.

Prices Of Raw Materials for Foundry Use

CORRECTED TO SEPT. 25

Iron		Scrap	
No. 2 Foundry, Valley	$26.75	Heavy melting steel, Valley	$19.50 to 20.00
No. 2 Southern, Birmingham	27.50	Heavy melting steel, Pittsburgh	20.00 to 20.50
No. 2 Foundry, Chicago	26.75	Heavy melting steel, Chicago	18.50 to 19.00
No. 2 Foundry, Philadelphia	29.60 to 30.10	Stove plate, Chicago	23.50 to 24.00
Basic, Valley	25.75	No. 1 cast, Chicago	26.50 to 27.00
Malleable, Chicago	27.25	No. 1 cast, Philadelphia	24.50 to 25.50
Malleable, Buffalo	27.25 to 29.00	No. 1 cast, Birmingham	24.00 to 25.00
Coke		Car wheels, iron, Pittsburgh	25.00 to 25.50
Connellsville foundry coke	6.00 to 6.50	Car wheels, iron, Chicago	23.50 to 24.00
Wise county foundry coke	7.00 to 7.50	Railroad malleable, Chicago	19.50 to 20.00
		Agricultural malleable, Chicago	20.00 to 20.50

Low Iron Production

Pig iron production in all grades, as shown by the figures of the American Iron and Steel Institute, suffered a slump during the first six months of 1919. The first half of 1918 and the last half of the same year both show greater production than does the first half of 1919. If the present rate of production is maintained throughout the remainder of the year, the total for 1919 will fall short of 1918 by 6,495,641 tons. This estimate was made before the strike introduced additional restraining influences.

The slump in blast furnace production during the first few months of the year is responsible to a large extent for the poor showing and the number of stacks blown in during July gave indication that unaffected by untoward circumstances, the last half year's would excell the first by a wide margin. Whether this will hold true will depend largely on labor conditions.

Pig iron production for the first six months by grades was as follows: Basic, 7,910,295 tons; bessemer and low phosphorus, 5,181,621 tons; foundry including ferrosilicon, 2,436,023 tons; malleable, 465,823 tons; forge or mill, 104,874 tons; ferromanganese, 106,056 tons, and spiegel, 38,136 tons. Merchant iron or iron made for the market totaled 4,499,133 tons, while iron made for the maker's use totaled 11,779,042 tons. It is noteworthy that the proportionate discrepancy between the first half 1919 production and the two six months' periods of 1918 is less marked in foundry grades than in the other classifications. This year fell behind the first half of 1918 by 182,698 tons, and lacked 190,513 tons of equalling the last half of last year. The corresponding comparison in both basic and bessemer grades shows this half year well over a million tons behind either half of last year. There was a deficiency in malleable iron production of 44,773 tons as compared with the last half of 1918 and 141,495 tons as compared with the first half of that year. As pig iron production invariably follows the demand, it is evident that with prosperity in foundry lines, these grades may closely approach the two six months periods of 1918.

Nonferrous Improves

The general upward trend in all lines of castings manufacture is particularly noticeable in nonferrous plants. The full return of automobile production has carried with it an increased demand for miscellaneous aluminum and alloy castings. The building revival has brought a great demand for hardware sundries, plumbing supplies and equipment for domestic use. A meeting of the Brass Manufacturers' association held in Detroit last week brought out the report that all brass casting plants have ample work, even beyond the limit of their labor facilities. This association is made up principally of those engaged in producing plumbing supplies. The prices of nonferrous metals have not yet been affected in any material way by the steel strike. Prices on brass foundry raw materials based on New York are: Copper, 21.50c; lead, 6.05c; tin, 54.75c; antimony, 8.50c; aluminum, No. 12 alloy, producers' price, 31.50c; and open market zinc is quoted at 7.00c, St. Louis.

Comings and Goings of Foundrymen

RALPH M. HILL, formerly with the Missouri Malleable Iron Co., East St. Louis, Ill., has been made president of the newly incorporated East St. Louis Casting Co. which will do jobbing work in light and medium gray-iron castings. John W. Eschenbrenner is secretary and Frank J. Kurrus is vice president of the new company.

W. J. Rowley has been placed in charge of the Huber Mfg. Co. foundry at Marion, O.

Fred E. Coughlin has accepted a position with the Laconia Car Co., Laconia, N. H.

John Blume formerly with the Holt Mfg. Co., Peoria, Ill., has been made assistant foundry superintendent for the Avery Co., Peoria.

Anthony Dobson has been placed in charge of a newly established branch office of the Carborundum Co., Niagara Falls, N. Y., at Detroit.

William Rohlman has resigned his position as foundry foreman for the Hoover Suction Sweeper Co., New Berlin, O.

Pierce G. Smith has been named vice president of the American Malleables Co., Lancaster, N. Y., and Owosso, Mich. Mr. Smith formerly was sales manager of the company.

H. E. McIntyre has been appointed general foreman of the new foundry of the Saginaw Products Co. division of the General Motors Corp., Saginaw, Mich.

L. E. Purnell recently has been made district manager at Cleveland for the Ajax Metal Co., Philadelphia. The new offices of the company are in the Schofield building, Cleveland.

Robert Field has resigned as foundry foreman for the Fairbanks Co., Rome, Ga., to become associated with the pig iron and coke department of that company in Cleveland.

W. J. Hughes has resigned as foundry superintendent for the H. & B. American Machine Co., Pawtucket, R. I., to take charge of the foundry of the Woonsocket Machine & Press Co., Woonsocket, R. I.

Frederick A. Stevenson formerly with the Detroit plant of the American Car & Foundry Co. has been made assistant vice president in charge of operations, with headquarters in New York.

A. A. Schneider has been assigned charge of the exports, imports and domestic sales of pig iron, manganese, chrome and other ferroalloys, coal and coke for the American Steel Export Co., New York.

William G. Hammerstrom, formerly general superintendent of the Lynchburg Foundry Co., Lynchburg, Va., has been made general superintendent for the Steel Castings Corp., Altavista, Va.

Alfred J. Saxe has been placed in charge of the branch office, established recently at 231 Insurance Exchange building, Chicago, by the Automatic Furnace Co., Dayton, O., manufacturer of automatic smokeless furnaces, chain grates, engines, etc.

Edward Smith, who formerly was foreman of the H. V. Newbigginy Pattern Works, St. Catherines, Ont., Canada, recently has accepted a position as foreman patternmaker for the Peerless Pattern Works, Buffalo, N. Y.

Joseph A. Hall has resigned as superintendent of the Tod-Booth plant of the United Engineering & Foundry Co., Youngstown, to become superintendent of the fireproofing department of the General Fireproofing Co. with headquarters and manufacturing plant in the same city.

William Turner, who comes to the United States from Canada, has been made superintendent of the foundry of the Ingersoll-Rand Co., at Phillipsburg, N. J. He succeeds Arthur Smith, who took his father's place as superintendent some time ago, but who resigned recently.

W. Edward Lindsay has been made engineer of the Lancaster Structural & Foundry Works, Lancaster, Pa., which recently purchased the plant of the Lancaster Machine & Structural Works of that city. Edgar G. Hess, formerly with the Lancaster Foundry Co. has been made works manager of the new company.

Charles P. Derleth has been made St. Louis representative for the Celite Products Co., New York City. About 14 months ago Mr. Derleth enlisted for chemical warfare service and prior to that was sales representative of the J. B. Ford Co., Wyandotte, Mich. He is a graduate of the University of Illinois.

E. Phelps Langworthy, formerly assistant works manager of the American Steel Foundry, Indiana Harbor, Ind., has been made manager of the steel castings plant of the American Radiator Co., Buffalo. G. W. Merrefield, formerly with the Clark Equipment Co., Buchanan, Mich., has been appointed assistant to Mr. Langworthy and will have charge of sales.

Auguste Griffoul who for the past few years has been foreman of the brass foundry department of Babcock & Wilcox Co., Barberton, O., has accepted a position as superintendent of foundries for the Flour City Ornamental Iron Co., Minneapolis. Mr. Griffoul's brother, Marcel Griffoul, has been made brass foundry foreman for the Babcock & Wilcox Co.

J. F. Shea recently has taken over the plant and equipment formerly owned by the Delta Foundry & Machine Corp. with which company he was employed as manager. A new partnership between Mr. Shea and his former foreman, Mr. Dixon, has been formed to operate the plant on nonferrous casting work under the name of the Marine Castings Co., 116 Fifty-seventh street, Brooklyn.

Society Will Establish Headquarters

The American Society for Testing Materials has taken steps to establish permanent headquarters in the building of the Engineers' club, 1315-17 Spruce street, Philadelphia. Temporary quarters were taken up on the first floor of this building on Sept. 13, pending completion of alterations now being made on the third floor where the society's permanent home will be established. The facilities will include an auditorium on the second floor, subject to the requirements of the society, and the committee rooms, and offices on the third floor.

Observations on Chills, Cops, Cranes, etc.

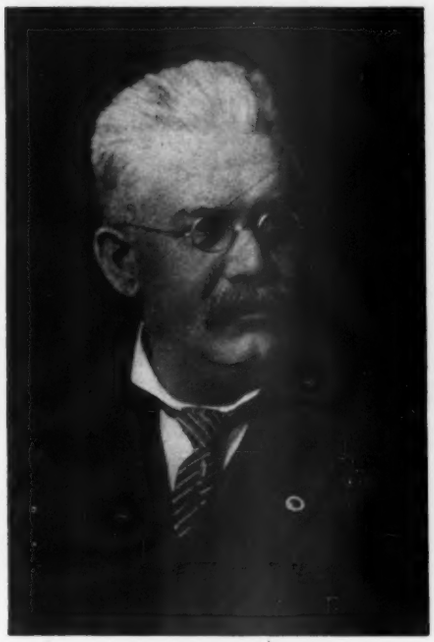
(*Concluded from page* 711)

We walked over and he explained to me that he had carried the entire length of the charging platform out into the shop for a distance of six feet. He kept his large ladles on each end of it and on the center he dumped the shop scrap. Every morning an iron box with one end open like those used in open-hearth steel plants was laid on the floor and all the scrap from the previous day's cast piled into it. When it was filled, one of the cranes picked it up and dumped it on the platform alongside the charging door. The box was then

returned, set on a truck and taken into the dog house. Here all the scrap, gates, etc., were gathered up in the same way and loaded into the box. The car was then pushed back to where the crane could catch the box which was lifted up to the platform and dumped as before. "It is quite an improvement," said Bill, "on the Irish locomotive we used to have, you know the one I mean one wheel in front and two starting bars behind."

Theodore O. Vilter

Theodore O. Vilter, president of the Vilter Mfg Co., Milwaukee, died Thursday night at his summer home on Pine lake, Wisconsin, aged 62 years He had been in failing health for several months. He was chairman of the general committee in charge of the meeting of the American Foundrymen's association at Milwaukee in 1918, and had served as president of the Milwaukee Metal Trades association and also of a Wisconsin association of ice machinery manufacturers. He was born Oct. 25, 1857, at Oldenburg, Germany, coming to America while a schoolboy. At 17 he began to earn his living



THEODORE O. VILTER

as a blacksmith's helper, later serving an apprenticeship as a machinist and finally he became foreman in the shop of Peter Weisel where he started his apprenticeship. He was able a few years later to buy an interest in the company, which was known as the Weisel & Vilter Mfg. Co. In 1887 Mr. Vilter and his brothers bought the interest held by Mr. Weisel, enlarging the business and changing the name to the Vilter Mfg. Co. The company specialized in refrigerating machinery and during the war marine engines were built in quantity for the Emergency Fleet corporation. Mr. Vilter was a director of the National Foundrymen's association and the National Metal Trades association and, in addition held positions of trust in numerous Milwaukee industrial bodies.

The Damascus Bronze Co., Pittsburgh, has issued a trade publication under the title *Journal of Better Bearings.* The first number, dated August, 1919, is an attractive magazine of 10 pages. It describes the products of the Damascus Bronze Co., and in a lighter vein gives illustrations and reasons why high grade bronze should be used for bearings.

The Mt. Vernon Car Mfg. Co., Mt. Vernon, Ill., is planning a car wheel foundry to produce 700 wheels per day. Neiler, Rich & Co., Manhattan building, Chicago, Ill., are the engineers in charge.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

An addition to its plant will be erected by the N. & S. Foundry Co., Seattle.

The Adler Stove & Range Co., Carnegie, Pa., has been acquired by the Keighley Mfg. Co.

The Champion Brass Works, Coldwater, Mich., has increased its capital from $20,000 to $75,000.

Erection of an addition is being planned by the Keeler Brass Works, Grand Rapids, Mich.

An addition is being erected at the plant of the Duriron Castings Co., Dayton, O.

The Union Steel Casting Co., Pittsburgh, will build a plant at 6100 Butler street.

Plans are being prepared for the erection of an addition, 100 x 250 feet, to the plant of the East Penn Foundry Co., Lehigh, Pa.

The Guerney Foundry Co., Ltd., Toronto, Ont., recently increased its capital from $750,000 to $2,000,000.

Erection of a foundry, 60 x 180 feet, is contemplated by the Pacific States Motor Truck Co., Seattle, which was recently incorporated.

The Monarch Foundry Co., Greenwood avenue and the Grand Trunk railroad, Detroit, will build a foundry, 100 x 200 feet.

A foundry, 65 x 120 feet, will be erected by the Eagle Foundry Co., Twenty-sixth street, Minneapolis.

Plans are being prepared for the erection of an addition to the plant of the Stroh Castings Co., Detroit.

A branch foundry which was built a year ago by the Arneson Foundry Co., Kenosha, Wis., will be occupied in the future as the main plant, and an additional structure, 80 x 225 feet, will be erected.

The International Malleable Iron Co., Guelph, Ont., is having plans prepared for the erection of an addition to its plant, 120 x 190 feet.

The Birmingham Machine & Foundry Co., Birmingham, Ala., plans the erection of a plant addition.

The first cupola at the central foundry of the Saginaw Products Co., Saginaw, Mich., was tested out recently.

A contract has been let for the erection of an addition at the Saco-Lowell Shops, Newton, Mass., to be 160 x 200 feet.

Plans for the constructuion of a foundry addition, 70 x 120 feet, are being prepared for the National Foundry Co., East Whitman, Mass.

Fire recently damaged the pattern shop of the Springfield Foundry Co., 3207 Smallman street, Pittsburgh.

Erection of a small addition, 35 x 60 feet, is contemplated by the National Bronze Foundry Co., Cleveland.

Contracts for the erection of a plant addition have been awarded by the Ensign Foundry Co., Toledo, O.

The directorate of the Wadsworth Foundry Co., Wadsworth, O., recently authorized an increase in capital from $15,000 to $100,000.

Paul Lemaitre, Ltd., Montreal, Que., has been incorporated to carry on the business of machinist and iron founder, with $90,000 capital, by Joseph Savage, Albert Sevigny and Emil A. Brodeur.

The Clarksville Foundry & Machine Shop, Clarksville, Tenn., is replacing a portion of its plant which was recently damaged by fire.

Gohmann Bros. & Kahler, New Albany, Ind., operating a stove foundry, are building an addition, 60 x 174 feet.

Fire recently damaged the plant of the General American Tank Corp., East Chicago, Ill., including the brass foundry, car and insulating shop.

The Malleable Iron Fittings Co., Branford, Conn., has started on the erection of an extension, 23 x 92 feet.

The Bond Foundry & Machine Co., Manheim, Pa., contemplates the erection of an addition, 25 x 150 feet.

Organization of a subsidiary company at Bath, Pa., is reported planned by the Penn Foundry & Machine Co., Allentown, Pa.

Contracts for the erection of a foundry have been let by the Montreal Locomotive Works, Ltd., 145 St. James street, Montreal, Que.

The gray iron foundry, which is under construction for the Thomas Davidson Mfg. Co., Montreal, Que., is nearing completion.

An increase in capital from $65,000 to $155,000 recently was made by the Atlas Brass Foundry Co., Columbus, O.

Two additions, 80 x 100 feet and 80 x 150 feet, will be erected at the plant of the Anderson Foundry & Machine Works, Anderson, Ind.

A movement is on foot to build a foundry at

Belvidere, N. J., for the manufacture of iron and brass castings. Oscar Smith, formerly of the Ingersoll-Rand Co., is at the head of the project.

The Iron City Foundry, Hamilton, O., is reported planning the erection of a plant addition.

Construction of an addition is under way at the plant of the Atlantic Foundry Co., Cleveland.

The Frost Mfg. Co., Kenosha, Wis., brass founder, will erect an addition to its foundry and build a new office building.

The Williams Foundry & Machine Co., Akron, O., recently awarded a contract for an addition, 60 x 145 feet.

An office building, 2-stories, 70 x 77 feet, will be erected at the plant of the Buffalo Foundry & Machine Co., Buffalo.

Erection of an addition to its machine shop and foundry is contemplated by the Slinger Foundry & Machine Co., Portage, Wis.

Bids will be taken shortly for the erection of plant additions by the Trenton Malleable Iron Works, Trenton, N. J.

The Moore Plow & Implement Co., Greenville, Mich., will build a foundry, 50 x 80 feet. F. P. Allen & Son, Grand Rapids, Mich., are engineers in charge.

The Woods Method Corp., Greenfield, Mass., has been incorporated to make castings, etc., with $99,000 capital, by Edward D. Woods, John L. Eppler and M. B. Markle.

The Gabrielson Mfg. Corp., Syracuse, N. Y., machine shop and foundry supplies, recently was incorporated with $50,000 active capital, by A. Meldrum, M. V. White and C. Gabrielson.

Plans are being prepared by Architect Henry Raeder, Chicago, for the erection of a foundry for the Maytag Co., 211 West Fourth street, Newton, Iowa.

Frank D. Chase, Inc., engineer, 645 North Michigan avenue, Chicago, is drawing plans for the erection of a foundry addition for the Ohio Steel Foundry, Lima, O.

Construction of an addition to its foundry will be started soon at the plant of the E. H. Bardes Range & Foundry Co., Cincinnati. The building will be 100 x 100 feet.

William J. Thiele, Herman J. Widmar and J. M. Gastman recently were named as the incorporators of the Cambria Car & Foundry Co., Fleetwood, Pa. The company is capitalized at $50,000.

Plans have been prepared for the erection of two buildings, one 80 x 80 feet and the other 40 x 50 feet, for the Sunray Stove Co., Delaware, O.

The Gleason Works, 1000 University avenue, Rochester, N. Y., has awarded a contract to A. Friederich & Sons, 710 Lake street, for the construction of a foundry.

The May Foundry Co., capitalized at $150,000, recently was incorporated in Delaware by F. R. Hansell, Philadelphia, J. Vernon Pimm and E. M. MacFarland, both of Camden, N. J.

Contracts have been awarded by the Union Motor Truck Co., Bay City, Mich., for the erection of a plant, 100 x 500 feet and a foundry, 60 x 120 feet.

The Coppus Engineering & Equipment Co., Worcester, Mass., manufacturer of turbines, pumps, etc., is reported contemplating the erection of a brass foundry.

A plant containing more than 120,000 square feet of floor space is being erected for the Adirondack Steel Foundries Corp., Colonie, N. Y. C. W. Sherman is president of the company.

Erection of a foundry, 43 x 120 feet, and a loading platform, 66 x 240 feet, is contemplated by the General Railway Signal Co., Lincoln Park, Rochester, N. Y.

The Pittsburgh Rolls Corp., Forty-third street, Pittsburgh, is reported planning the erection of a foundry and machine shop. The company is located at Forty-first and Willow streets.

The Holmes Foundry Co., Port Huron, Mich., will begin operations in its new plant about Oct. 1. Its old plant was damaged by fire about six months ago.

William E. A. Wheeler and associates of Washington, N. J., recently were named as the incorporators of the Bay Way Foundry, Inc. The company is capitalized at $200,000.

Plans have been completed for the erection of an addition to the plant of the Pittsburgh Valve, Foundry & Construction Co., Twenty-sixth street and the Allegheny Valley railroad, Pittsburgh.

The Peninsular Brass Works, Detroit, is building a new plant, which when completed will have about 150 per cent greater capacity than its present building. A. W. Fussey is president.

The Gilson Mfg. Co., Port Washington, Wis., has awarded contracts for a foundry and machine shop addition, 60 x 160 feet. The company specializes in castings for swivel chairs and furniture, but also manufactures gasoline engines, small tractors and other machinery. Harry W. Bolens is president.

Notice of incorporation with $250,000 capital, has been filed by the Continental Castings Corp., New York. The company was chartered by H. O. Bonner, F. E. Beidler and J. J. Flannery, 149 Broadway.

G. W. Johnson, former superintendent of the Chippewa Foundry & Machine Co., Chippewa Falls, Wis., is organizing a new corporation for the manufacture of engines. A plant is now being erected.

Syracuse, N. Y., interests have organized the Gatliph-Knapp Pattern & Castings Co., Inc. The company, which is capitalized at $25,000, was incorporated by William H. Catliph, John R. Sheldon, John Pickard and Charles E. Knapp.

Plans are being prepared for the erection of an addition, 105 x 120 feet, to the foundry of the Campbell Foundry Co., Harrison, N. J. When completed the building will be equipped with two cranes of five and ten tons capacity.

The Raymond Mfg. Co., New York, machine shop and foundry supplies, recently was incorporated with $150,000 capital, by H. O. Zurich, 5 Wilson court, M. Soken, 178 DeKalb avenue, Brooklyn, N. Y., and M. Cohen, 1226 Boston road.

The Lanham Cotton Cultivator Co., Empire building, Atlanta, Ga., will erect a plant to include, a machine and erecting shop, 50 x 120 feet, woodworking shop, shipping department, forge shop and foundry.

Plans have been completed for a plant for the Manufacturers' Foundry Co., Waterbury, Conn. The plant will consist of a foundry, 50 x 120 feet, a storage building, and a machine shop, 50 x 50 feet.

A recent incorporation is that of the Boyertown Brass Foundry Co., Boyertown, Pa. The company, which is capitalized at $50,000, was incorporated by W. M. Johnson, A. R. May and Garrett J. Henves.

The Moline Iron Works, Moline, Ill., has purchased the Moline Three-I baseball park, which will be utilized as a site for a malleable foundry, 110 x 400 feet, and an enameling and finishing building, 110 x 360 feet. Construction contracts have been awarded.

According to a report the present plant of Sutton, Steele & Steele, Forney avenue, Dallas, Tex., will be greatly enlarged. The improvements will include an iron foundry. Walter L. Steele is president of the company, which was recently incorporated in Delaware with $1,000,000 capital.

Capitalized at $40,000 the East St. Louis Castings Co., East St. Louis, Ill., which was recently incorporated, has taken a lease on a building which it is now converting into a foundry for the production of medium sized gray iron castings. Practically all equipment has been purchased and the company expects to engage in active business the latter part of October. Ralph W. Hill is president.

New Trade Publications

REFRACTORY MATERIAL.—The Quigley Furnace Specialties Co., New York, has published an 8-page illustrated booklet in which a refractory plastic material for bonding fire brick and kindred uses, is described and illustrated. The booklet contains testimonials, illustrations, etc., pertaining to the use of this material in the foundry.

NONFERROUS METALS.—White & Bro., Inc., Philadelphia, have prepared a 24-page booklet pertaining to the manufacture of nonferrous metals. The latter part of the booklet is devoted to illustrations of various departments of the company's plant, and include, the laboratory, the electrolytic table, a corner of the balance room, the copper warehouse and test departments.

BLOWERS.—The Buckeye Blower Co., Columbus, O., has prepared bulletin No. 10, which describes and illustrates multi-blade fans for mechanical ventilation, forced or induced draft, mine ventilation, dry kiln where hot blast is used, waste heat installations of all kinds, mechanical systems where space is limited and exhausters. Various data are given. A chart for determining frictional resistance or static pressure in inches, water gage, is given.

SAND MIXER.—The National Engineering Co., Chicago, is circulating an 8-page booklet in which a sand mixer is described and illustrated. The mixer consists of a stationary circular pan in the center of which is located a vertical shaft, to which is keyed a central supporting casting or cross head. This casting rests on a turret in which are the bearings for the central shaft, which is operated by bevel gearing located below the machine. The supporting casting carries the plows and mullers. A lever operated door located in the bottom of the pan serves to discharge the sand from the mixer.

SWING CUT-OFF SAWS.—A 4-page illustrated circular is being distributed by the Oliver Machinery Co., Grand Rapids, Mich., in which swing cut-off saws are described and illustrated. The frames of these saws are supported by trunions which are independent of the countershafts. The frames are hung low from large screws which are supported in the hangers by means of hand wheels, permitting adjustment. The saw arbors are mounted in separate yokes which are removable from the frames and which are held in finished slots securely bolted. The arbor bearings are automatically lubricated.

BUILDING CONSTRUCTION.—A 40-page booklet designed to illustrate and explain the equipment used and the methods employed in the construction of modern buildings under a system developed by the Blaw-Knox Co., Pittsburgh, has been prepared by that company. The booklet is profusely illustrated.

TOOL GRINDER.—A 4-page leaflet has been prepared by Alfred Herbert, Ltd., Coventry, England and New York, in which an oscillating tool grinder is described and illustrated. In this grinder the grinding wheel oscillates rapidly past the tool, which is always in full view. Grinding is performed without water but a fan connected to a streamline duct in the base of the toolholder, draws all dust and chips away. The wheel spindle, self-contained countershaft, loose pulley and all shafts in the gear box with the exception of the eccentric shaft, run on oil-tight, dust-proof ball bearings.

POWDERED COAL.—The Combustion Economy Corp., Chicago, has published bulletin No. 2 in which the history and the possibilities of powdered coal as a fuel are described. Types of furnaces, draft, preparation of powdered coal for burning, storage, separation of scrap iron from coal, crushing, drying, distributing to furnaces, air supply, control, carburization and adaption to furnaces, are some of the points in the use of this fuel, which are given. A line drawing of a typical powdered coal burning system is also given.